USAID | PREDICT

FROM THE AMERICAN PEOPLE

# 2017 ANNUAL REPORT

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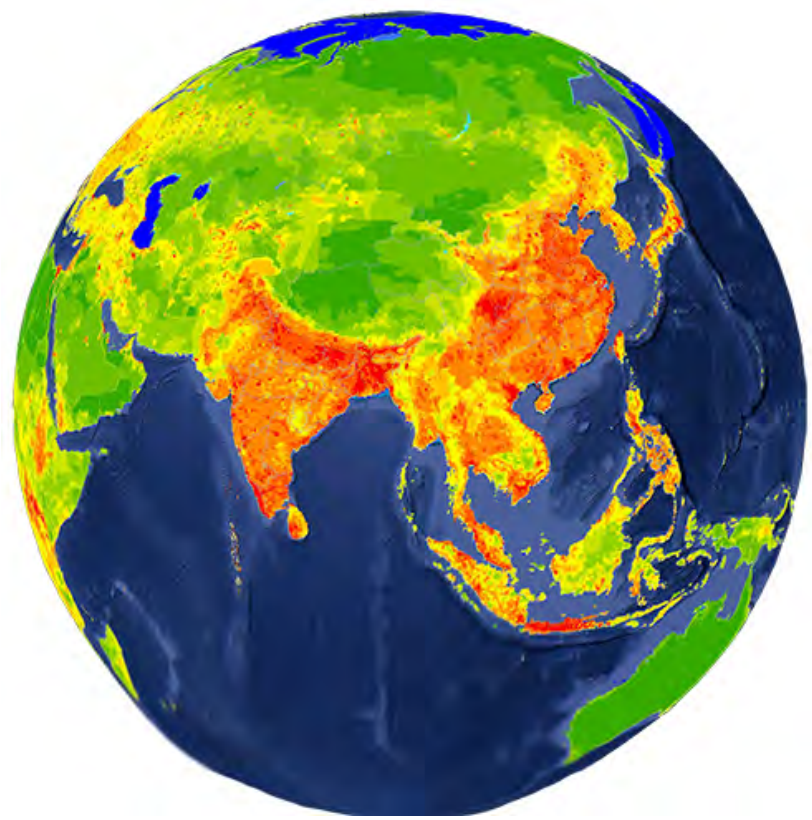
## ON THE COVER

Crop farmers in Myanmar sift grain directly outside of Kjwe Min Gu cave. The cave in Hpa-an is one of PREDICT/Myanmar's targeted sites for One Health surveillance. In Hpa-an, the PREDICT team is collecting samples from rodents, bats, primates, livestock, and humans to better understand viral transmission and spread between animals and people.
Photo: Marc Valitutto, Smithsonian Institution and PREDICT/Myanmar.

# I. PREFACE

USAID | PREDICT

FROM THE AMERICAN PEOPLE

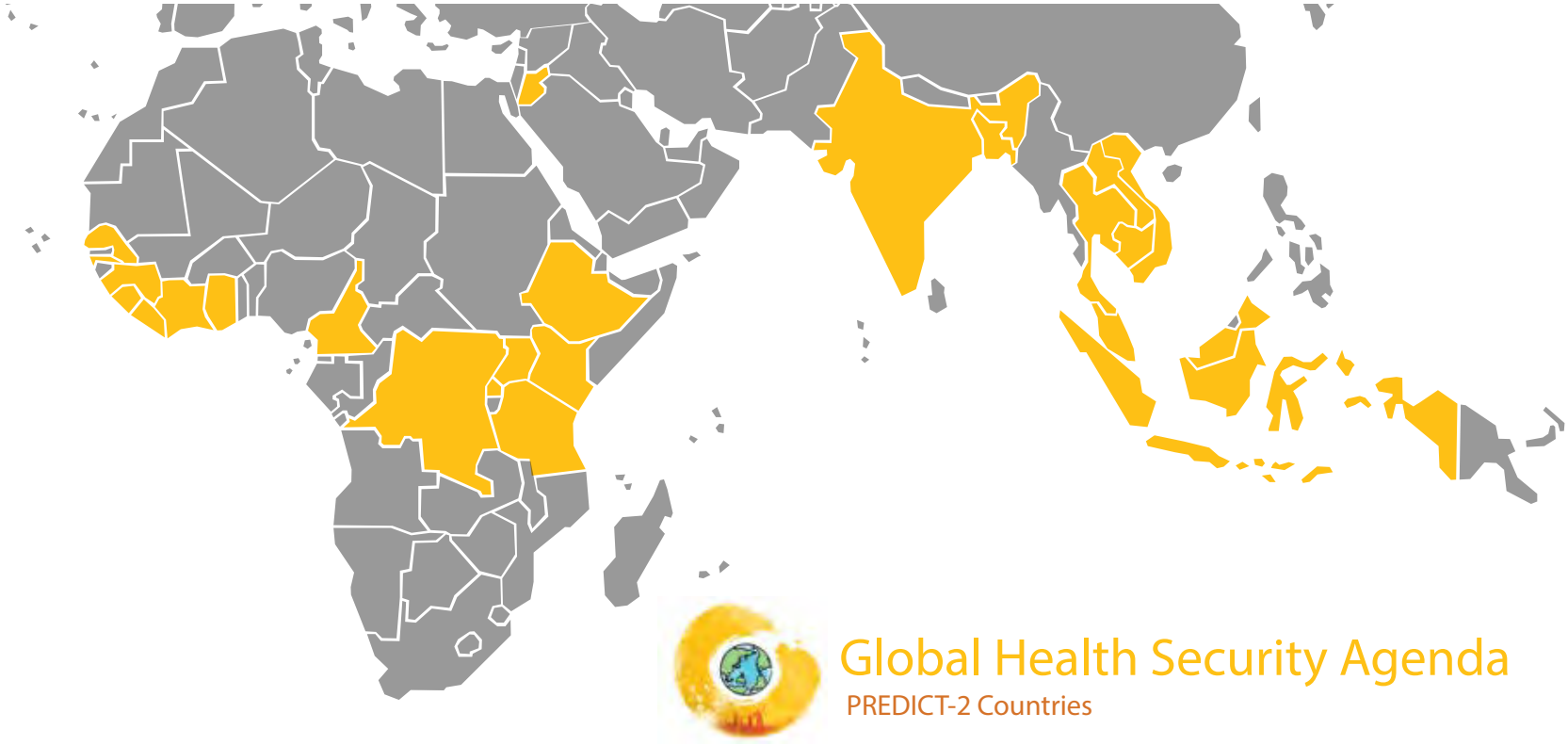


PREDICT, a project of USAID's Emerging Pandemic Threats (EPT) program, was initiated in 2009 to strengthen global capacity for detection and discovery of viruses with pandemic potential that can move between animals and people. Those include filoviruses, such as the ebolavirus and Marburg virus; influenza viruses; coronaviruses, the family to which SARS and MERS belong; and paramyxoviruses, like Nipah virus. PREDICT has made significant contributions to strengthening global health security by improving surveillance and laboratory diagnostic capabilities for new and known viruses.

Now working with partners in 30 countries, PREDICT is continuing to build platforms for priority viral surveillance and for identifying and monitoring zoonotic pathogens or those that can be shared between animals and people. Using the One Health approach, the project is investigating the behaviors, practices, and ecological and biological factors driving disease emergence, transmission, and spread. Through these efforts, PREDICT is improving global disease recognition and beginning to develop strategies and policy recommendations to minimize pandemic risk.

## REDUCING PANDEMIC RISK, PROMOTING GLOBAL HEALTH

## Supporting the Global Health Security Agenda in Africa and Asia




PREDICT is working to strengthen global capacity for detection and discovery of zoonotic viruses with epidemic and pandemic potential, including the Ebola, influenza, and Zika viruses that have been recent causes of devastating disease and necessary impetuses of dramatic and resource-intensive responses. The project is actively and diligently implementing GHSA activities in target countries aimed at developing and operationalizing strategies to improve disease management efficiencies in the short term and reduce zoonotic pathogen spillover, amplification, and spread in the long term, through improved public health policies and risk-reducing mitigation efforts. In every country of engagement, we work hand-in-hand with governmental and non-governmental stakeholders to develop and implement activities that are tailored to country and regional priorities and specifically designed to strengthen capabilities and ensure lasting positive effects from our engagements.

Using the One Health approach to improve capacity for **zoonotic disease** management and **surveillance** in a cross-sectoral manner and enable early detection of known and emerging disease threats, PREDICT is making significant contributions to strengthen **biosafety and biosecurity**, **national laboratory systems**, and **reporting** efficacy in all engagement-countries, while also improving the stability of these systems through One Health **workforce development**.

## The PREDICT Consortium and Management

The USAID/PREDICT Consortium is a functionally collaborative working team that implements the project through in-country partners and benefits from the experience of world leaders in zoonotic disease detection and surveillance, epidemiology, disease ecology, and risk characterization. PREDICT's consortium includes partnerships with ministries of health, agriculture, and environment and implementing university and NGO partners in 30 countries.

### USAID/PREDICT global-level consortium institutions

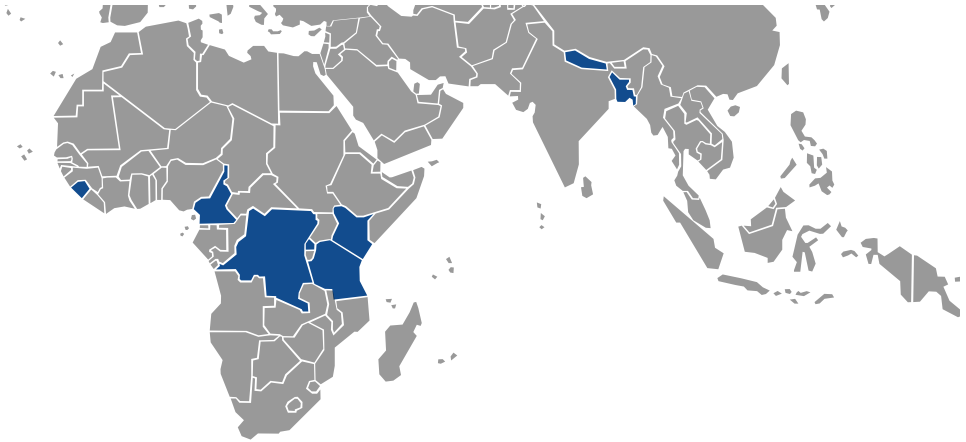
- **UC Davis' One Health Institute**, based in the most highly-rated veterinary school in the world, is active all over the globe, working at the interface of animals, people, and the environment to solve complex problems that impact health and conservation.
- **EcoHealth Alliance** is the first group to identify bats as the reservoir of SARS-like coronaviruses, to define hotspots of emerging diseases, and identify drivers of disease emergence.
- **Metabiota, Inc.** has made seminal discoveries regarding the role of hunting of nonhuman primates and food handling in moving animal pathogens to humans.
- **Smithsonian Institution and the National Zoo** are among the founders of the field of conservation biology.
- **Wildlife Conservation Society** was the first conservation organization with a dedicated team of wildlife veterinarians deployed around the world, with programs focused on environmental stewardship and health problem-solving.
- Other global partners include **Columbia University**; **Epidemico (HealthMap)**; and the **International Society for Infectious Disease**.

# II. MONITORING & EVALUATION

| PREDICT ACTIVITY | DEFINITION | MONITORING INDICATOR |
|---|---|---|
| Strengthening Systems for Prevention, Detection and Response | | |
| Outbreak Response | Providing technical assistance with outbreak response if requested by the government and approved by USAID | Description of outbreaks supported; Percentage of countries with improved capacity to conduct outbreak investigations |
| One Health Surveillance and Risk Characterization | Conducting animal and human sampling; Conducting biological and/or behavioral data collection; Collecting data on ecological and epidemiological factors associated with virus evolution, spillover, amplification, and/or spread; Collecting data on animal-human contact for characterization of behavioral risk; Prioritization and description of identified intervention points to inform development of risk mitigation approaches | Risk mitigation strategies recommended for implementation and/or scaling up; Characterization of risk factors and/or interfaces associated with spillover, amplification and/or spread; Intervention points prioritized for development of risk mitigation approaches |
| Modeling and Analytics | Development of tools to better understand the emergence of disease pathogens | Viral, bacterial, or other disease risk pathway models or maps developed and/or refined |
| Lab Strengthening: PREDICT viral family screening | Laboratories have adequate infrastructure (facilities, lab equipment, staff, etc.) and sufficient training to conduct consensus PCR (cPCR) testing for the minimum four viral families (Corona, Paramyxo, Influenza, Filo) using PREDICT protocols and can perform, or have support to perform, cloning and sequencing to confirm PCR positives and to identify the virus present | Percentage of labs improving quality assurance and safety procedures; Percentage of labs able to perform EPT2/GHSA prioritized testing and # of tests performed; |

| PREDICT ACTIVITY | DEFINITION | MONITORING INDICATOR |
|---|---|---|
| **Workforce Capacity** | | |
| Workforce Development: Training and Materials Developed | Personnel and/or students participating in the following types of trainings: Field Sampling, Information Management, Laboratory Techniques and Assay Development, and Risk Characterization | Number of faculty members that received OH training or professional development; Number of future professionals trained; Number of OH fellows placed; Number of current professionals trained |
| Workforce Development: Local Capacity | PREDICT training and employment of local or regional staff members in host countries | Total number of in-country staff who are from the host country or region |
| **One Health Strengthening** | | |
| Advancement and improvement of One Health practices and policy | Development of One Health resources (including guidelines, technical protocols, standard operating procedures, standardized data collection instruments and protocols, and instructional tools and manuals for implementing risk mitigation recommendations) to provide evidence-based guidance on the operationalization and/or implementation of One Health principles and approaches; Inform policy change through evidence-based solutions | Description of application of OH approaches in the workforce; Description of national/regional coordination mechanisms showing improved capacity; Description of global, regional or country strategies under implementation; List of educational materials developed; Tools developed for implementation and operationalization; Evidence-based informational resources developed including policy briefs, research papers, situational analysis/risk assessment, and zoonotic prioritization resources |

## OUTBREAK RESPONSE ASSISTANCE 2016-2017



Sierra Leone • Cameroon • Democratic Republic of Congo • Rwanda • Tanzania • Kenya • Nepal • Bangladesh

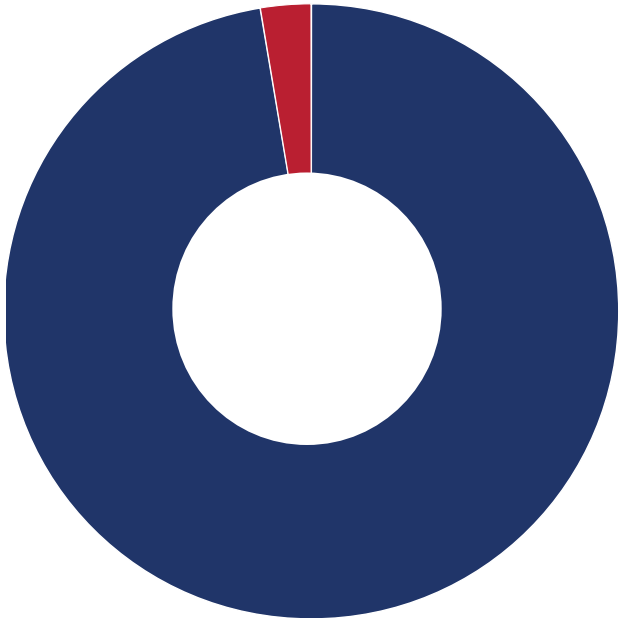
**13**

Outbreak events

**8**

Countries

## STAFF IN COUNTRY 2016-2017



Staff from host country  Staff from outside of host country

**226**

Total staff

**97%**

From host country

**1**

Staff from region

**220**

Staff from host country

**6**

Staff not from country or region

## ONE HEALTH TOOLS & RESOURCES 2016-2017

**895**
Educational materials developed

**54**
Evidence-based informational resources

**47**
Publications

**7**
Tools developed for implementation

**5**
Policy briefs

## ONE HEALTH STRENGTHENING 2016-2017

**24**
Countries with national or regional coordination mechanisms showing improved capacity

**18**
Countries with global, regional or country level strategies under implementation

**17**
Countries with high-level multisectoral and/or multilateral events coordinated

**15**
Countries coordinating community One Health events

## RISK FACTORS AND RISK INTERFACES 2016-2017

**41**

Risk factors and risk interfaces characterized since the beginning of PREDICT-2 in 2014

## RISK MODELS AND MAPS 2016-2017

**59**

Models or maps developed, refined, analyzed, and described

**19**

Viral

**1**

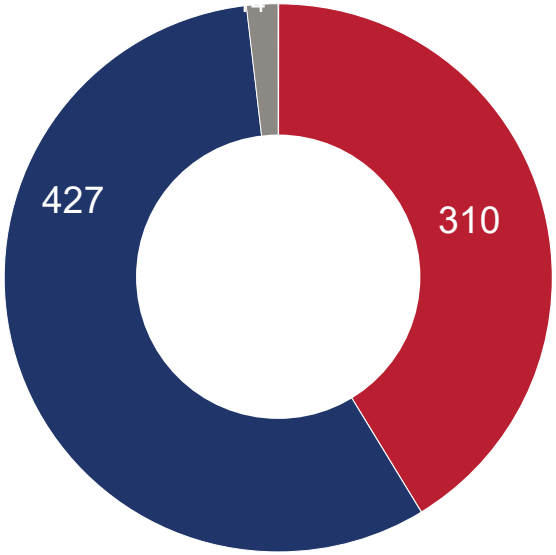
Bacterial

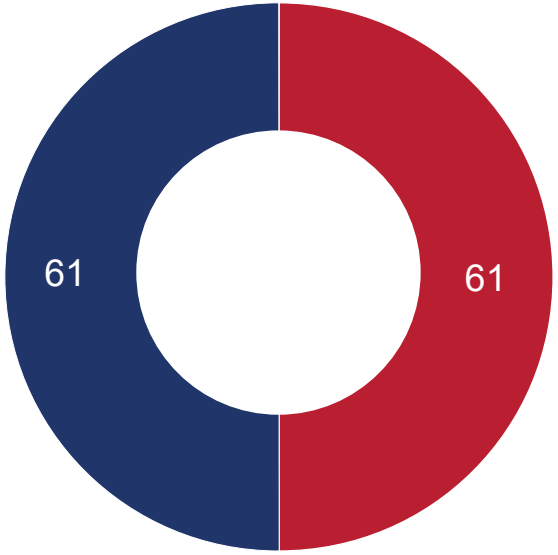
**39**

Disease risk

# ONE HEALTH WORKFORCE CAPACITY 2016-2017

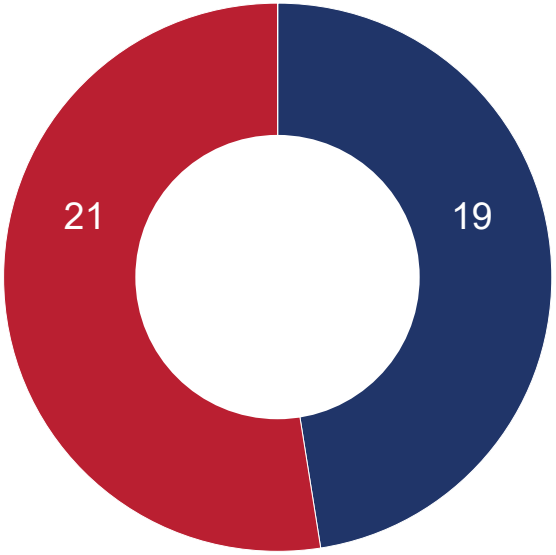
Current professionals trained

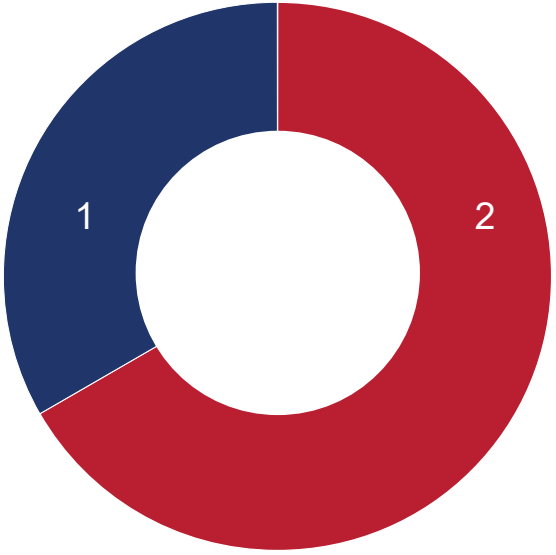



Future professionals

Faculty members who received training




One Health fellows placed

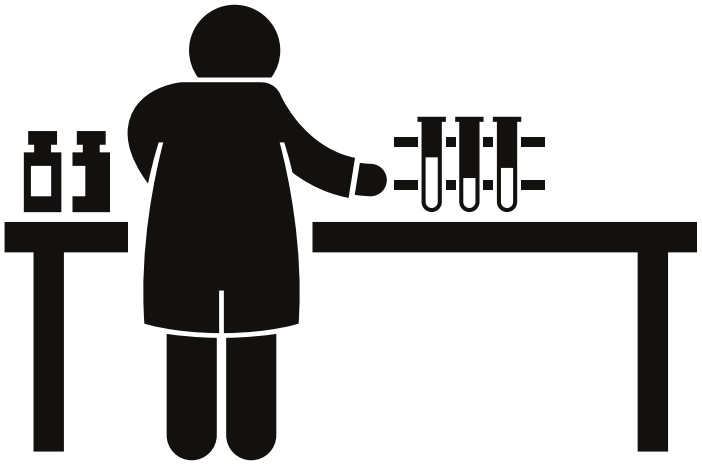
Males trained  Females trained  Trainees who did not declare gender

## LAB STRENGTHENING 2016-2017

**120,502**
Tests performed

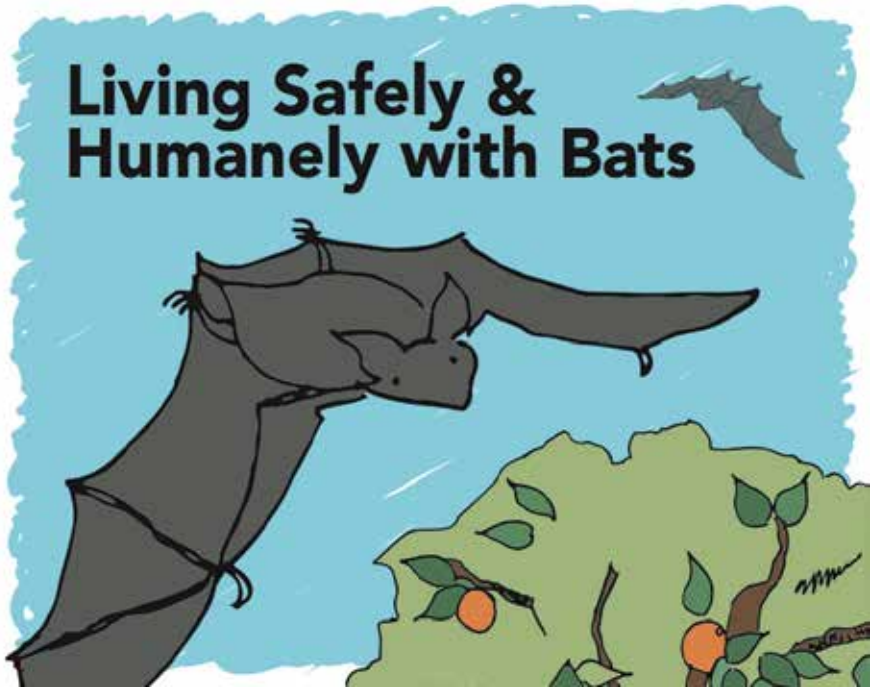
**27**
Labs improving quality assurance and safety procedures

**23**
Labs able to perform PREDICT prioritized testing



## INTERVENTION POINTS 2016-2017

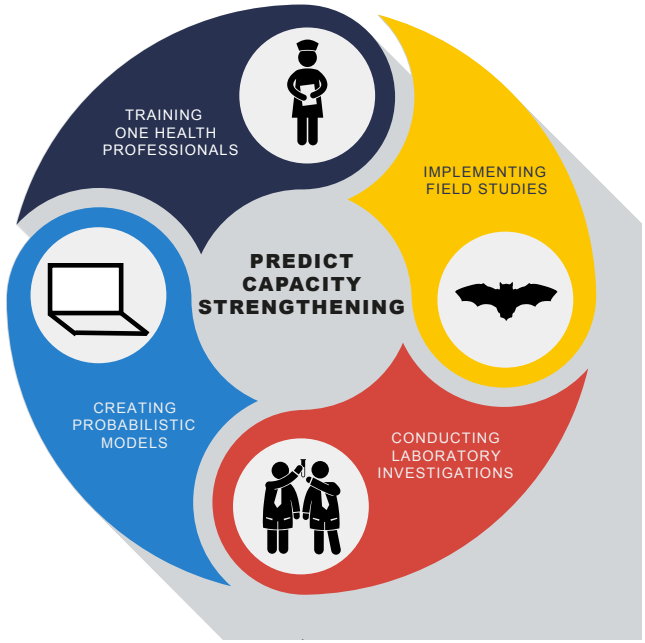
Prioritized strategic planning and behavior communication to safely and humanely live with bats in and around human dwellings




Development of risk mitigation processes

# III. GLOBAL REPORT

## Capacity Strengthening




*PREDICT-2 uses an integrated approach to train in-country personnel on One Health competencies that enable field surveillance activities, laboratory testing for priority zoonotic diseases and other emerging threats, outbreak assistance, and data modeling to improve our understanding of zoonotic disease risks at key wildlife-livestock-human interfaces where spillover events may occur.*

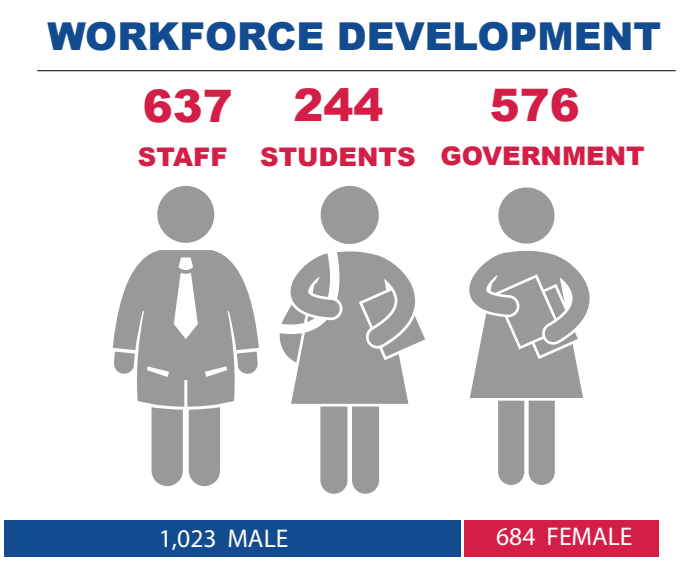
### Improving surveillance capabilities in hot spot regions around the world

In this era of global connectivity, it is critical to strengthen the international system of health professionals that can detect and prevent spillover events of emerging viruses before they spread across borders. To this end, PREDICT has been working in many countries in Africa and Asia to conduct 'on the job', longitudinal training to mentor the next generation of One Health professionals and strengthen global health security. Since the start of the PREDICT-2 project in October 2014, more than 1,729 individuals (39% women) have been trained, including 1,637 individuals (95% of all individuals trained) in active-sampling countries where we are implementing One Health surveillance activities. Of these individuals, 576 (35% in total) are host country government staff, representing a major contribution to long-term improvements in national capabilities for zoonotic disease detection and response.

### Strengthening regional capacity for disease surveillance across African countries

PREDICT teams across Africa and Asia have been regularly involved in capacity building exchanges in their respective regions. Recently, there have been several significant training exchanges across West and East Africa between PREDICT teams. For example, the PREDICT/Senegal team received training and technical assistance from members of the PREDICT/Rwanda and PREDICT/Tanzania teams to strengthen their capacity to conduct zoonotic disease surveillance. During these trainings, experienced PREDICT veterinarians from Rwanda and Tanzania provided Senegal field teams with hands-on instruction in critical skills required for implementation of surveillance activities. Although the key participants in the trainings were PREDICT staff, representatives from government agencies also attended the training to bring knowledge back to their respective ministries. The trainings focused on biosafety, animal sampling techniques, human syndromic surveillance, cold chain management, sample storage and transport, and data management. Furthermore, PREDICT/Sierra Leone hosted members of the PREDICT/Senegal and PREDICT/Guinea teams for an intensive training series disease surveillance activities.

## WORKFORCE DEVELOPMENT




**22 individuals with unreported gender*

*Since 2014, PREDICT has trained over 1,700 individuals in critical skills required by the One Health workforce.*

Training exchanges, such as these, exemplify the PREDICT trainer-to-trainer approach and our commitment to building capacity across regions among the existing workforce beyond the project. In addition to transferring critical disease surveillance skills among country workforces, these trainings also provide a venue for One Health professionals to learn about techniques and best practices in other countries working towards implementing sustainable One Health teams and platforms. As a result of these regional trainings, PREDICT teams are more equipped to conduct animal and human field activities at surveillance sites and to transfer these skills and knowledge to local partners, students, and government staff. Overall, these trainings represent a key part of PREDICT's strategy for strengthening regional networks and mechanisms for One Health and zoonotic disease surveillance.

*PREDICT/Bangladesh team, consisting of veterinarians, lab scientists, field technicians, and epidemiologists, is housed within the Institute of Epidemiology, Disease Control & Research the coordinating body of the National One Health Secretariat. Photo: PREDICT/Bangladesh.*

## Forging One Health partnerships to investigate spillover and characterize risk in Asia

Working across universities, ministries, and international organizations, PREDICT-2 is showing success as key partnerships are strengthened and the power of collaboration is harnessed to characterize risk in several ways. In Cambodia, the One Health approach has united the human and animal health sectors to conduct concurrent surveillance of wildlife, domestic animals, and humans at key interfaces such as cross-border rodent trading hubs. In Bangladesh, the National One Health Secretariat has formed as a high level partnership across the Ministry of Health, Department of

Livestock Services, Forestry Department, and laboratory network including PREDICT iccdr,b laboratory. In Thailand, PREDICT-2 partners with FAO and the Department of Livestock Development to conduct triangulated human, wildlife, and domestic animal surveillance in areas where Nipah virus has been previously found, and behavioral risk is being investigated in high-risk communities to complement the laboratory risk data.

## Preparing for outbreaks – training the workforce in Ebola-affected countries

PREDICT teams in many countries are invited by governments to assist in outbreaks where undiagnosed diseases are involved and time is of the essence. Being prepared to respond in an appropriate and timely manner is critical to contain an outbreak before it spreads to new populations. Being able to assist and respond well involves understanding chain of command, along with having trained personnel and logistics support in place to mobilize at any given time. This year, PREDICT-2 intensified capacity strengthening efforts for outbreak preparedness and response through group trainings.

For example, PREDICT/Liberia trained 22 individuals, including 12 field technicians and 2 government wildlife officers, most with no prior wildlife handling experience, to safely catch and sample bats and rodents; use PPE; handle and transport clinical samples with cold chain; and enter data into EIDITH. For the first time, Liberia has the capability for conducting disease surveillance in wildlife. In Guinea, PREDICT-2 trained groups with diverse veterinary, biology, and ecology backgrounds to participate in Ebola Host Project activities. This training involved three days of classroom sessions and three days of field activities to equip participants with core skills required for safe implementation of zoonotic

*PREDICT/Liberia team collects samples from insectivorous bats as part of the Ebola Host Project seeking to identify host reservoir species of Ebola virus in the West Africa region. PREDICT training is strengthening the animal health sector's workforce for zoonotic disease surveillance, a major contribution to the region's health security. Photo: PREDICT/Liberia.*

disease surveillance and outbreak response activities. One of the outcomes was enabling community sensitization and sample collection from rodents, livestock, and bats.

Additionally, ongoing online learning activities involving a PREDICT eBook resource and tabletop exercises are utilized for training on protocols involved in disease detection and outbreak response. In April 2017, PREDICT/Tanzania conducted a tabletop exercise to work through a mock outbreak that began in pigs and could involve wildlife and humans. This mock outbreak exercise increased team readiness to participate in future response efforts and is currently being refined for future use to increase readiness for other PREDICT teams across the globe.

## PREDICT training resources are publicly available

Several of our project training materials, protocols, and eBook resources are available to the public to encourage sharing of the knowledge and skills essential for safe and effective One Health surveillance, detection, and characterization of zoonotic disease threats. The materials and resources below are accessible at this link.

### Publicly available guides and protocols

**Biosafety, Cold Chain and Emergency Preparedness Resources**

- Basic Laboratory Safety (English-pdf, French)
- Biosafety and PPE Use (English-pdf, French)
- Emergency Preparedness (English-pdf, French)
- Implementing Cold Chain for Safe Sample Transport and Storage (English-pdf)
- Packing and Shipping Biological Samples (English-pdf)

**One Health Surveillance & Field Sampling Guides**

- Avian Sampling Methods (English-pdf)
- Bat Sampling Methods (English-pdf, French)
- Bushmeat Sampling Methods (English-pdf)
- Livestock Sampling Methods (English-pdf)
- Non-Human Primate Sampling Methods (English-pdf)
- Rodent Sampling Methods (English-pdf)
- Safe Animal Capture and Sampling (English-pdf)
- Small Carnivore Sampling Methods (English-pdf)

**Behavioral Risk & Qualitative Research Guides**

- Qualitative Research: Introduction & Observational Research Methods (English-pdf)
- Qualitative Research: Focus Groups, Ethnographic Interviews, & Data Analysis (English-pdf)

For more information or for information about other training resources, contact us at predict@ucdavis.edu.

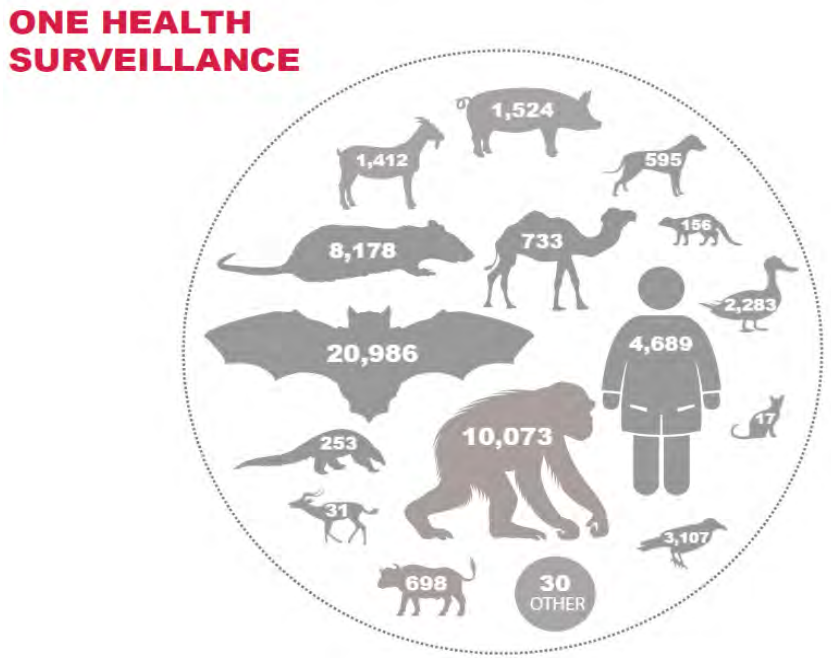
## One Health Surveillance – Characterizing Biological and Ecological Risk

### Highlights

We continued optimization of our overall surveillance strategy for animals and humans in coordination with USAID and Emerging Pandemic Threats-2 (EPT-2) partners to detect viral sharing across species, identify viral spillover to humans, and characterize biological and ecological risk.

We refined our surveillance data collection strategy and tools for risk characterization based on field application and in-country feedback including: 1) site and event characterization with data on animal-human contact, landscape change, and animal and human host ecology; 2) animal information with data on animal contact with people and condition at sampling; 3) sample data, including sample type and condition; and 4) human questionnaire data, including information on occupations, travel, medical history, and animal contact to be collected along with human biological samples.

As surveillance activities involving humans were planned and implemented, we reinforced concurrent surveillance guidelines by distributing standardized concurrent site definitions that emphasize detection of viral sharing and spillover as a result of close proximity contact, or effective contact, between wildlife shedding viruses and susceptible people (and domestic species where relevant). Guidelines emphasize sampling people with high-risk occupations at concurrent sites within a month of sampling animals and sampling ill patients year-round at clinic and hospitals within the catchment area of concurrent sites.




At the PREDICT Semi-Annual Consortium Meeting in January 2017, we reviewed global guidelines with regional leads and partners during sessions on operationalizing surveillance, cross-border coordination, and sharing surveillance targets along common epizones. At the second Semi-Annual Consortium Meeting in Sept 2017, we reviewed Year 3 surveillance accomplishments and set the stage for Year 4 as the final year of sampling and field activities. We reviewed surveillance priorities, including minimums for sampling wildlife and humans over the life of project, priority sample type targets for collection and testing, and reviewed success stories in the field, particularly PREDICT's progress over the past year in implementing human surveillance in both hospital and community settings.

We engaged with Food and Agriculture Organization (FAO) counterparts on surveillance coordination, both broadly in EPT-2 partner meetings and via regional and local meetings to develop opportunities for collaboration, plan standardized data collection, and synchronize surveillance activities in Asia. For countries in Africa, we re-adjusted plans mid-year with respect to coordinated triangulated surveillance on livestock sampling to accommodate FAO directive to focus on only priority zoonotic diseases.

We communicated with local Ministries, local FAO staff and in-country partners to provide updates on surveillance activities and reporting of surveillance data. We confirmed a list of key contacts for outbreak response activities, as well government and ministry contacts for approval of test results for public release. In addition, we implemented outbreak response rapid reporting and completion of checklists to streamline activities in the event a host country government requests PREDICT assistance in outbreak response. Finally, in collaboration with the Capacity team, we renewed the Institutional Animal Care and Use Committee (IACUC) protocol for safe and ethical animal sampling activities to integrate consortium partner activities in all countries under a single protocol and to update all methods and procedures to better align with PREDICT-2 surveillance plans and targets. We also updated small mammal and rodent sampling methods to align with latest best practices for safe and humane blood collection from facial and saphenous veins and to eliminate the retro-orbital bleeding technique.

## Targeted monitoring for zoonotic viruses with pandemic potential at specific high-risk interfaces

We implemented longitudinal and concurrent surveillance at highest priority sites targeting sampling opportunities for wildlife in contact with people and livestock, livestock in contact with people (coordinated with FAO as appropriate), and initiated surveillance of humans at high occupational risk for zoonotic spillover at sites where wildlife and livestock were proposed for sampling and humans presenting with undiagnosed syndromes at collaborating clinics/hospitals.

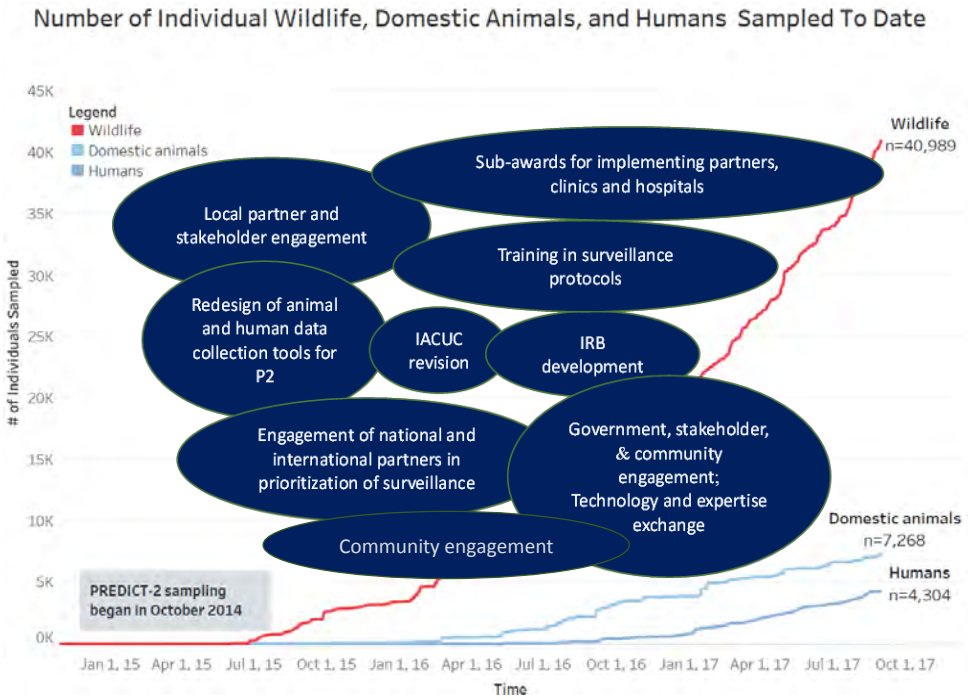



*Figure 1. PREDICT activities related to planning and implementing surveillance along the timeline for sampling wildlife, domestic animals, and humans.*

**PREDICT has sampled over 47,000 animals and 4,000 people since sampling began in October 2014.** Over the past six months, field activities have substantially ramped up with respect to sampling efficiency across wildlife, domestic animals, and humans (Figure 1).

## Wildlife

PREDICT made significant progress sampling targeted wildlife species, primarily bats, rodents, and non-human primates, at high-risk interfaces for zoonotic spillover and spread (Figure 2). Wildlife sampling activities at high-risk interfaces were implemented in 27 countries including: Bangladesh, Cambodia, Cameroon, China, Cote d'Ivoire, Democratic Republic of Congo, Egypt, Ethiopia, Ghana, Guinea, Indonesia, Jordan, Kenya, Lao PDR, Liberia, Malaysia, Mongolia, Myanmar, Nepal, Republic of Congo, Rwanda, Senegal, Sierra Leone, Tanzania, Thailand, Uganda, and Viet Nam.

## Livestock and other domestic animals

PREDICT has coordinated closely with FAO on planning and sampling livestock at sites designated for concurrent and triangulated surveillance wherever possible. **Concurrent livestock sampling activities were directly supported by FAO in** Viet Nam, Nepal, Bangladesh, Cambodia, Lao PDR, Malaysia, and Myanmar, and Kenya. PREDICT undertook additional livestock sampling in Bangladesh, Democratic Republic of Congo, Guinea, Sierra Leone, and Uganda. Together with PREDICT teams, FAO undertook sampling of livestock concurrently with wildlife sampling (and human sampling where possible) in Thailand, Indonesia, Nepal, Egypt, Jordan, Ethiopia, and Tanzania (Figure 3). Due to the recent change in FAO priorities, livestock sampling will likely not be prioritized further in **Liberia, DR Congo, Rwanda, Republic of Congo, Cameroon, Ghana, Senegal, Cote d'Ivoire.** In Ethiopia, Kenya, and Tanzania, livestock were a central focus for collaboratively prioritized field activities, and, in some cases, sampling was initiated by FAO. For future livestock work, PREDICT is evaluating the feasibility of

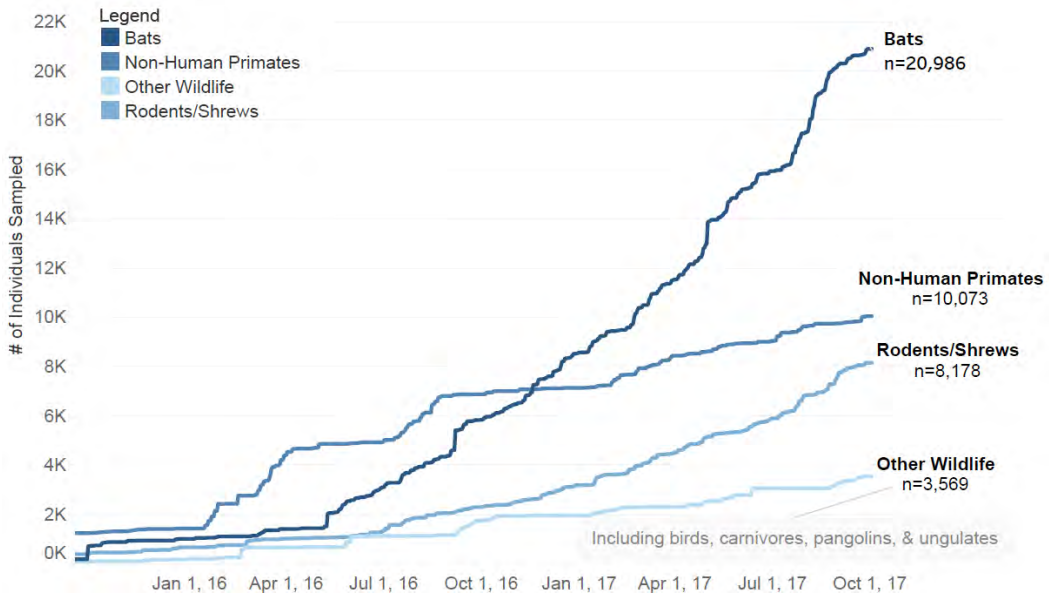



*Figure 2. Number of individual wild animals sampled to date, by taxonomic group (with data entered into EIDITH).*

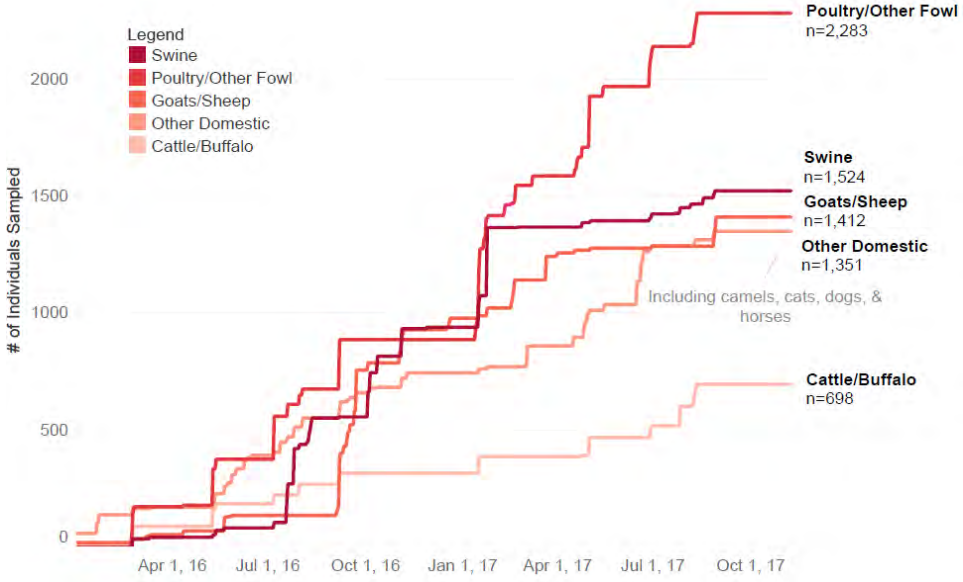



*Figure 3. Number of individual domestic animals sampled to date (with data entered into EIDITH).*

undertaking the additional fieldwork and laboratory testing of livestock in these few countries to ensure of integrity of our surveillance plans.

**Humans**

To date, **21** countries have received in-country ethical board approval for human biological surveillance, including Bangladesh, Cambodia, China, India, Indonesia, Lao PDR, Myanmar, Nepal, Thailand, Viet Nam, Cameroon, Cote d'Ivoire, DR Congo, Egypt, Ghana, Jordan, Kenya, Rwanda, Senegal, Tanzania, and Uganda. PREDICT shared a comprehensive human syndromic surveillance guide and human sampling protocol, detailing the collection of biological samples and risk characterization data for patients in clinics and hospitals.

Human biological sampling and risk characterization surveys using PREDICT's human questionnaire were initiated in **high-risk communities** in **14** countries: Bangladesh, Cambodia, China, Indonesia, Lao PDR, Myanmar, Nepal, Thailand, Viet Nam, Cameroon, Egypt, Jordan, Kenya, and Tanzania.

Human biological sampling and risk characterization **at hospitals and/or clinics** were initiated in **15** countries: Bangladesh, Cambodia, China, India, Indonesia, Nepal, Thailand, Viet Nam, Cameroon, Cote d'Ivoire, DR Congo, Rwanda, Senegal, Tanzania, and Uganda. Both community and clinic-based sampling efforts seek to identify viruses in people with frequent, direct, and often intense contact with wild animals.

In participating countries, people were sampled across a range of disease transmission interfaces within land use settings and anthropogenic activities that pose risk for viral spillover (Figure 4). Additional data were gathered through specific human questionnaire survey modules to characterize the biological, ecological, and behavioral risk inherent to these settings (See the *Investigating Behavioral Risk* section for more details).

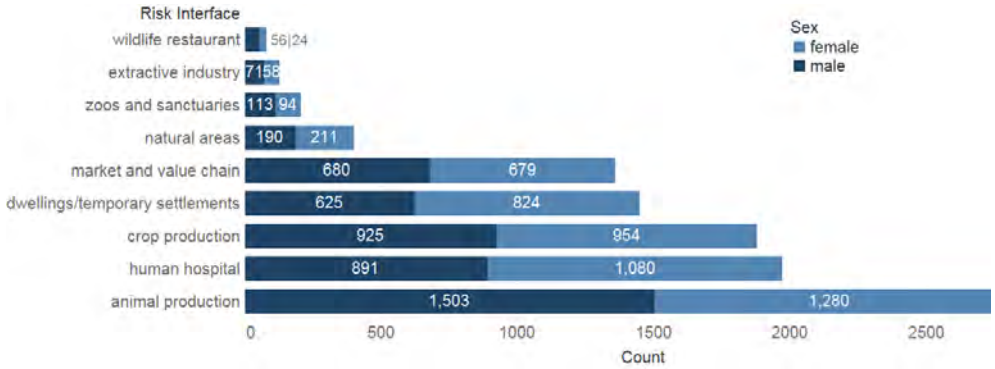



*Figure 4. High risk interface modules completed by individuals sampled in the community or patient clinical setting, disaggregated by gender (note: many individuals sampled had more than one disease transmission interface).*

## Viral spillover risk from wildlife is linked to habitat loss, exploitation of wildlife, and increasingly abundant animal species

Risk of spillover at the animal-human interface was further investigated by evaluating variation in the number of zoonotic viruses found in animal species to date, as reported in the scientific literature. In general, zoonotic viral species richness scales with wild mammal species richness when assessed at the order level, indicating that mammalian orders with more species are the source of more zoonotic viruses (Figure 5). However, at the species level, we found that risk of zoonotic viral spillover from animal host species has been highly correlated with trends in mammalian host species abundance and domestication status. Even among domesticated mammalian livestock, zoonotic viral richness was correlated with global abundance estimates for these species (Figure 6). Multivariate analyses of past spillover events revealed that domesticated species and wildlife species that have increased in abundance, despite widespread global environmental change, were more commonly a source of viral zoonoses compared to decreasing and threatened wildlife species. Causes for species declines were also found to be significantly related to risk of viral spillover; in fact, wildlife species that have declined due to exploitation and loss of natural habitat have been the source of more viral zoonoses than species that have declined for other reasons. These analyses indicate that habitat loss and exploitation of wildlife have been convergent drivers of species declines and viral spillover risk, and efforts aimed at mitigating these activities are likely to benefit public health and conservation.

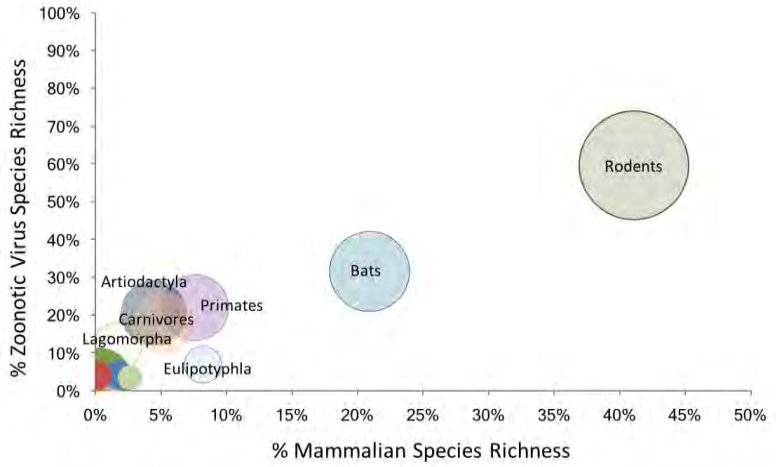



*Figure 5. Zoonotic viral species richness scales with wild mammal species richness when assessed at the order level indicating that mammalian orders with more species have been the source of more zoonotic viruses, and further analyses of risk at the species level is warranted.*

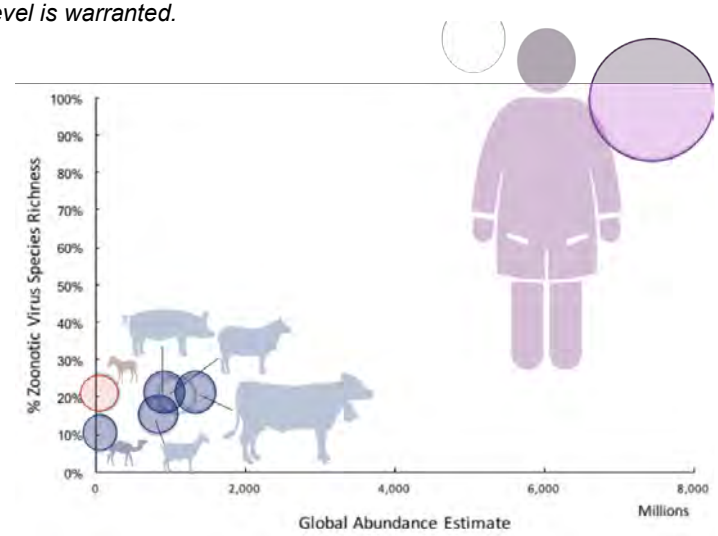
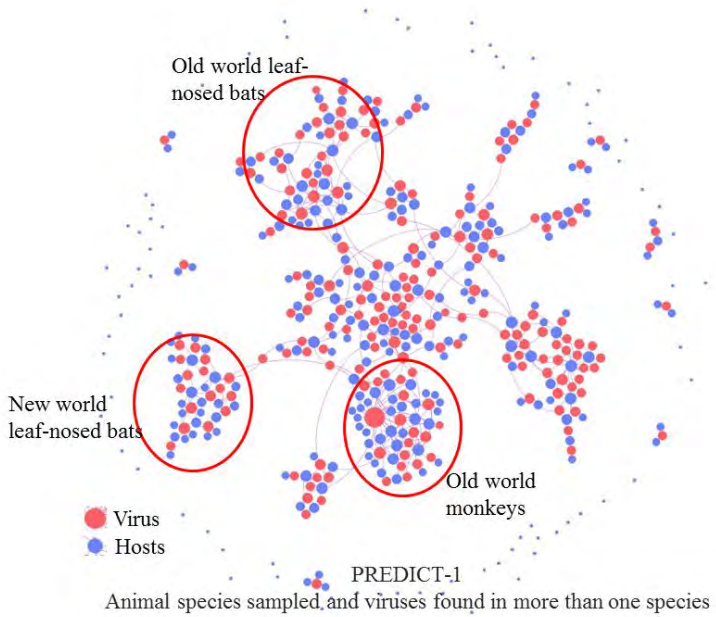


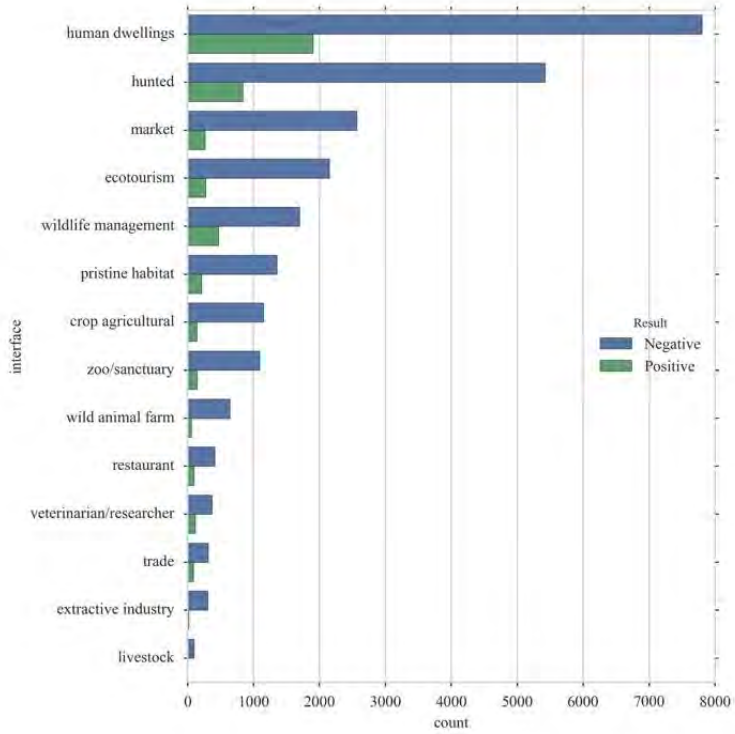

*Figure 6. At the species level, zoonotic viral richness in humans and domesticated mammalian livestock is correlated with global abundance estimates for these species.*

## Understanding risk of viral sharing and spillover at animal-human interfaces




Risk of viral spillover was further investigated with PREDICT-1 data on the epidemiological context for human contact with animals and possible direct and indirect disease transmission routes for all animals sampled from 2009-2014. We assessed sampling and testing effort for all host-interface combinations to evaluate power to detect differences across the 17 categorized interfaces investiagted in PREDICT-1.

Risk of viral spillover at all wildlife-human interfaces is being further characterized based on detection of: 1) known viruses, 2) novel viruses, and 3) viruses with high host plasticity, stratified by viral family as appropriate. Viruses with high host plasticity pose greater zoonotic risk and are more likely to




*Figures 5 and 6. Bipartite host-virus network showing viruses found in more than one species. Clustering of hosts shows viruses shared in taxonomically related host species (at left). Number of animals sampled at different interfaces and frequency of negative and positive test findings using PREDICT viral detection protocols (cPCR) (above).*

spread. To identify viruses with higher host plasticity and further understand clustering among hosts sharing the same viruses, we constructed a detailed network analysis of PREDICT-1 host-virus data. Animal species and viruses with highest centrality measures (higher degree and betweenness centrality) were identified.

Analyses are providing insight to optimize surveillance activities in PREDICT-2 and characterize risk for viral spillover and spread.

## Characterizing Biological and Ecological Risk for Viral Spillover, Amplification, and Spread

PREDICT developed a risk characterization strategy and initiated development of tools and packages to define risk at the individual level and characterize risk across populations. In all surveillance activities involving wildlife, domestic animals, and people, the same data are collected to facilitate risk biological and ecological risk characterization and host-pathogen dynamics at high-risk interfaces. Tools are now in development, in the form of tables and figures with key metrics to assist country teams in identifying the ecological and biological risk factors for viral spillover, amplification, and/or spread. In advance of completion of field data collection activities, the surveillance team is using previous publications based on PREDICT-1 data and/or global disease datasets to identify the points at which animal-human or animal-animal contact occurs that can result in spillover and to understand which practices and behaviors facilitate/promote virus spillover from wildlife into livestock or humans or from livestock to humans, persistence/amplification/spread in animals, and/or spread in humans. Findings from risk characterization for studies published in year 3 are summarized below, and will be shared with host country governments to inform future surveillance recommendations and support identification of interventions and public policy.

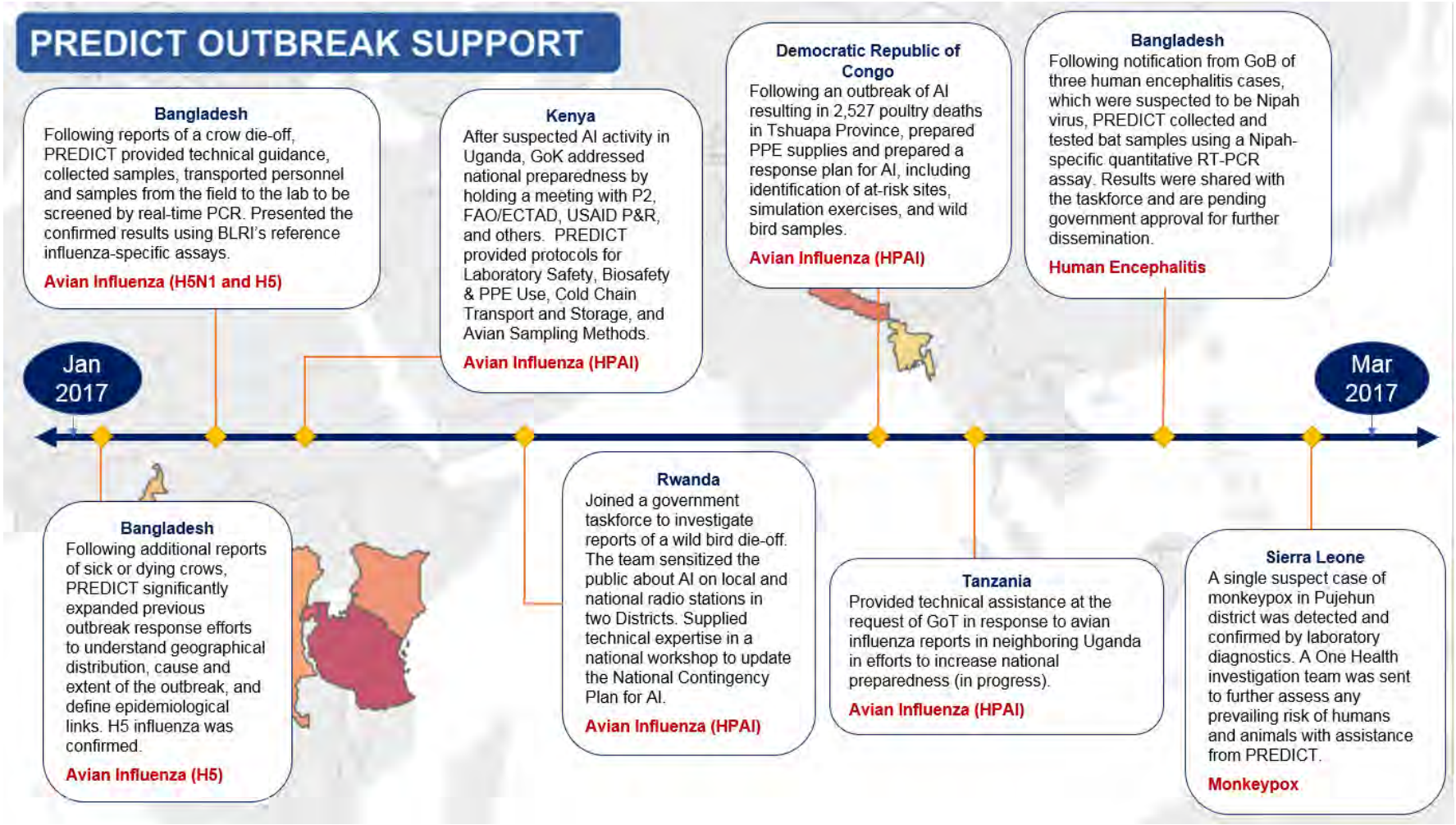
| COUNTRY | RISK FACTORS/INTERFACES DEFINED |
|---|---|
| **LAO PDR, CAMBODIA** | Bats are host to astroviruses shed in feces. Astroviruses are distributed widely, and some have been identified as a cause of gastroenteritis in humans and other mammals. Wildlife species living close to human habitats could represent a risk for transmission of astroviruses to humans and domestic animals (agent/host risk factor linked to potential for spillover; based on PREDICT data) |
| **LAO PDR, CAMBODIA** | Bats are host to a diverse array of coronaviruses (coronaviruses of animal origin were responsible for the Severe Acute Respiratory Syndrome [SARS] outbreak in 2003–2004 and the current epidemics of Middle Eastern Respiratory Syndrome [MERS] in the Arabian Peninsula and Korea). Findings are of importance for public health, as Lao PDR and Cambodia have a high biodiversity of bats, often at high-risk interfaces in close proximity to people (agent/host risk factor linked to potential for animal to human spillover; based on PREDICT data) |
| **CHINA** | Bats are hosts to novel filoviruses in China. Findings suggest that these viruses have been circulating in two bat species and that densely populated bat caves provide opportunity for cross-infection with different viruses. Considering their feeding habitats, fruit bats are often in close contact with domestic animals and human populations (host risk factor linked to potential for animal to animal or animal to human spillover; based on PREDICT data) |

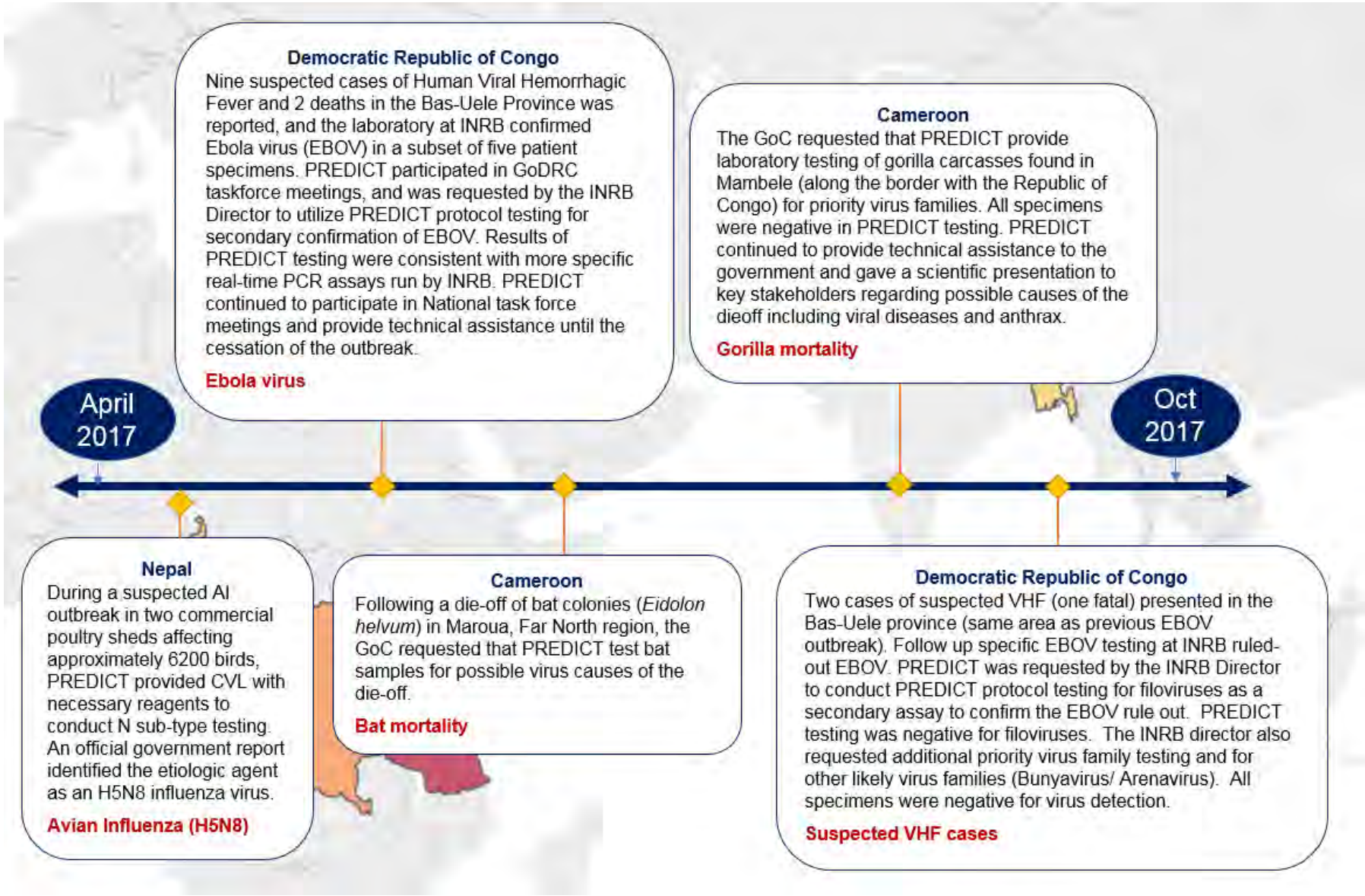
| | |
|---|---|
| **GLOBAL** | The expanding international wildlife trade combined with a lack of surveillance for key animal diseases in most countries represents a potential pathway for transboundary disease movement (host/agent risk factors linked to potential animal to animal or animal to human spillover, based on in-depth literature review of reports of OIE-listed terrestrial animal diseases in wild animals) |
| **GLOBAL** | The number of declared wildlife shipments into the USA has doubled since 2000, illustrating continually increasing demand, which reinforces the need to scale up capacity for border inspections, risk management protocols, and disease surveillance (host/agent risk factors linked to potential animal to animal or animal to human spillover, based on comprehensive data US Fish and Wildlife Services database) |
| **GLOBAL** | Bats are host to a diversity of viruses in the coronavirus (CoVs) family, and global diversity and distribution of CoVs in bats are non-random and driven by variation in the biogeography of bats (host/agent risk factors linked to potential animal to animal or animal to human spillover; based on PREDICT data) |
| **BANGLADESH** | Nipah virus was found in Indian flying foxes outside of the area currently recognized to be experiencing recurring outbreaks, suggesting spillover is possible anywhere in Bangladesh if a suitable strain and bat-human interface were present. Human activities, such as date palm sap harvesting, concurrent with viral circulation in local bat populations are likely to be the major driver of human outbreaks in Bangladesh (host/agent risk factor and high-risk interface linked to potential animal to animal or animal to human spillover; based on PREDICT data) |
| **EGYPT** | High MERS-CoV seroprevalence and the presence of active viral infection circulating in imported and resident camels are indications that MERS-CoV may have become ubiquitous in Egypt. Transport stress and close vicinity of imported camels during transport may precipitate disease dissemination, particularly in animals with latent infection and carrier animals (host/agent risk factor and high-risk interface linked to potential animal to human spillover) |
| **UGANDA/GLOBAL** | MERS-related CoVs are highly associated with bats and are geographically widespread (host risk factor linked to potential for animal to human spillover) |

| | |
|---|---|
| **GLOBAL** | Risk of emerging infectious zoonotic disease is elevated in forested tropical regions experiencing land-use changes, especially where wildlife biodiversity (mammal species richness) is high (host/environmental risk factor and high-risk interface linked to animal to human spillover, based on global data) |
| **GLOBAL** | Cave-roosting bat species exhibit a greater likelihood of viral sharing within caves (host risk factor linked to potential for animal to animal or animal to human spillover, based on global data and PREDICT 1 data) |
| **GLOBAL** | The proportion of known zoonotic viruses per species is predicted by phylogenetic relatedness to humans, host taxonomy (bats harbor a significantly higher proportion of zoonotic viruses than all other mammalian orders), and human population within a species range – which may reflect human–wildlife contact (host risk interface linked to potential for animal to human spillover, based on global data) |

## PREDICT Outbreak Investigations

Between Oct 2016 and Sept 2017, PREDICT provided support to government and international organizations during health events in 8 countries. Of these outbreaks, many involved technical support to government response teams. The Outbreak Response Timeline (below) describes the support provided during outbreak response efforts. Additional information on outbreak response efforts is included in the country-specific sections as relevant.


PREDICT OUTBREAK SUPPORT
Bangladesh
Following reports of a crow die-off, PREDICT provided technical guidance, collected samples, transported personnel and samples from the field to the lab to be screened by real-time PCR. Presented the confirmed results using BLRI's reference influenza-specific assays.
Avian Influenza (H5N1 and H5)
Kenya
After suspected AI activity in Uganda, GoK addressed national preparedness by holding a meeting with P2, FAO/ECTAD, USAID P&R, and others. PREDICT provided protocols for Laboratory Safety, Biosafety & PPE Use, Cold Chain Transport and Storage, and Avian Sampling Methods.
Avian Influenza (HPAI)
Democratic Republic of Congo
Following an outbreak of AI resulting in 2,527 poultry deaths in Tshuapa Province, prepared PPE supplies and prepared a response plan for AI, including identification of at-risk sites, simulation exercises, and wild bird samples.
Avian Influenza (HPAI)
Bangladesh
Following notification from GoB of three human encephalitis cases, which were suspected to be Nipah virus, PREDICT collected and tested bat samples using a Nipah-specific quantitative RT-PCR assay. Results were shared with the taskforce and are pending government approval for further dissemination.
Human Encephalitis
Jan 2017
Mar 2017
Bangladesh
Following additional reports of sick or dying crows, PREDICT significantly expanded previous outbreak response efforts to understand geographical distribution, cause and extent of the outbreak, and define epidemiological links. H5 influenza was confirmed.
Avian Influenza (H5)
Rwanda
Joined a government taskforce to investigate reports of a wild bird die-off. The team sensitized the public about AI on local and national radio stations in two Districts. Supplied technical expertise in a national workshop to update the National Contingency Plan for AI.
Avian Influenza (HPAI)
Tanzania
Provided technical assistance at the request of GoT in response to avian influenza reports in neighboring Uganda in efforts to increase national preparedness (in progress).
Avian Influenza (HPAI)
Sierra Leone
A single suspect case of monkeypox in Pujehun district was detected and confirmed by laboratory diagnostics. A One Health investigation team was sent to further assess any prevailing risk of humans and animals with assistance from PREDICT.
Monkeypox


April 2017
Oct 2017
Democratic Republic of Congo
Nine suspected cases of Human Viral Hemorrhagic Fever and 2 deaths in the Bas-Uele Province was reported, and the laboratory at INRB confirmed Ebola virus (EBOV) in a subset of five patient specimens. PREDICT participated in GoDRC taskforce meetings, and was requested by the INRB Director to utilize PREDICT protocol testing for secondary confirmation of EBOV. Results of PREDICT testing were consistent with more specific real-time PCR assays run by INRB. PREDICT continued to participate in National task force meetings and provide technical assistance until the cessation of the outbreak.
Ebola virus
Cameroon
The GoC requested that PREDICT provide laboratory testing of gorilla carcasses found in Mambele (along the border with the Republic of Congo) for priority virus families. All specimens were negative in PREDICT testing. PREDICT continued to provide technical assistance to the government and gave a scientific presentation to key stakeholders regarding possible causes of the dieoff including viral diseases and anthrax.
Gorilla mortality
Nepal
During a suspected AI outbreak in two commercial poultry sheds affecting approximately 6200 birds, PREDICT provided CVL with necessary reagents to conduct N sub-type testing. An official government report identified the etiologic agent as an H5N8 influenza virus.
Avian Influenza (H5N8)
Cameroon
Following a die-off of bat colonies (*Eidolon helvum*) in Maroua, Far North region, the GoC requested that PREDICT test bat samples for possible virus causes of the die-off.
Bat mortality
Democratic Republic of Congo
Two cases of suspected VHF (one fatal) presented in the Bas-Uele province (same area as previous EBOV outbreak). Follow up specific EBOV testing at INRB ruled-out EBOV. PREDICT was requested by the INRB Director to conduct PREDICT protocol testing for filoviruses as a secondary assay to confirm the EBOV rule out. PREDICT testing was negative for filoviruses. The INRB director also requested additional priority virus family testing and for other likely virus families (Bunyavirus/ Arenavirus). All specimens were negative for virus detection.
Suspected VHF cases

## Characterizing Behavioral Risk

The goal of PREDICT's behavioral risk activities is to generate a data-driven approach to better understand behaviors that increase the risks of viral emergence, transmission, and spread. Results from our work are intended to inform the development of potential population or policy-level intervention strategies that could reduce the spillover, amplification, and spread of zoonotic viruses and other emerging threats.

### Highlights

- To date, 540 professionals (42% women) in 30 countries around the world were trained on a variety of topics relevant to behavioral risk investigations.
- Numerous standardized frameworks were developed to enhance the rigor of 'mixed method' behavioral risk characterization; data collection via quantitative questionnaires; and qualitative interviews, focus groups, and participant observations.
- Key indicators and potential intervention points for behavioral risk reduction strategies were identified by an inter-disciplinary team of scientists with expertise in human and animal ecological and biological surveillance, viral detection and discovery, modeling and analytics, and behavioral risk ethnography. This One Health approach to analysis increases the potential that recommended structural interventions are holistic and, as a result, more appropriate, feasible, effective, and sustainable.

## Successes Stories

### Behavioral Risk Mitigation Capacity Building in 30 Countries

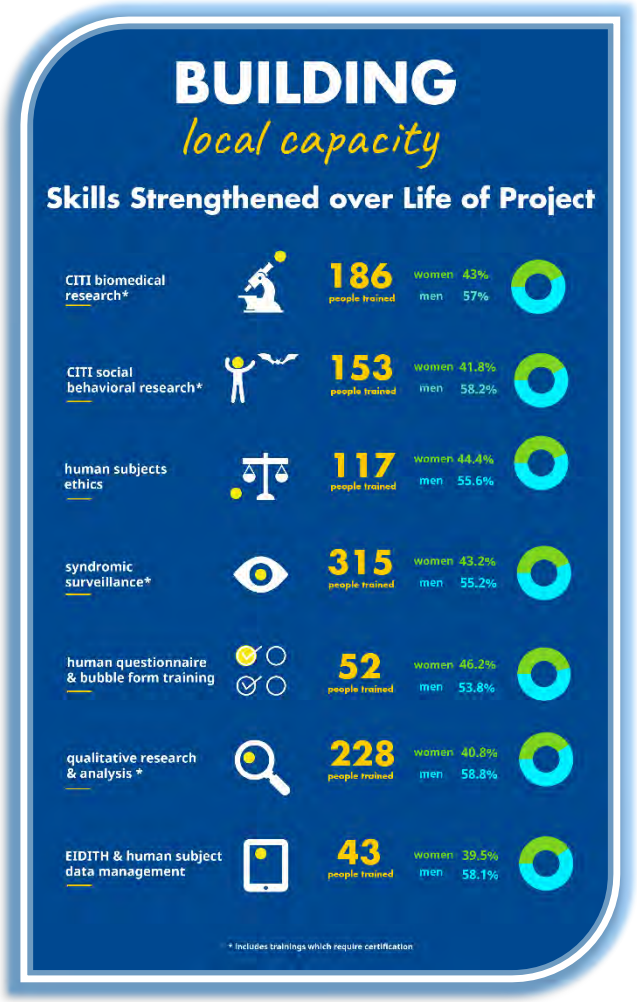



***Figure 1. Global capacity building in behavioral risk characterization***

*Figure 1* provides a snapshot of global capacity building in behavioral risk characterization, including a six-country live video training that was conducted in September 2017 with PREDICT teams in Bangladesh, China, Cote d'Ivoire, India, Indonesia, and Liberia. Topics covered included: Ethics in Human Subjects Research; Questionnaire Administration; Data Entry using digital EIDITH and hardcopy bubble forms; and Human Syndromic and Community Surveillance. Through this effort, PREDICT is strengthening local capacity, as well as regional capacity, through cross-country team partnerships.

## Standardizing Approaches to Studying Human Behavioral Risk

Animals and humans are sampled concurrently within PREDICT-2 sites as part of One Health surveillance activities. When humans are sampled, they also complete a questionnaire which covers a number of pertinent topics targeting behaviors that can impact the risk of zoonotic virus transmission. These quantitative questionnaire data are complemented with qualitative in-depth behavioral risk investigations in the form of ethnographic interviews, focus group discussions, and participant observation.

Our 'mixed method approach' (triangulation of quantitative and qualitative data) is designed so that the quantitative questionnaire data provides insight on the 'who', 'what', and 'when' of viral transmission and spread, while the qualitative data helps explain the 'why' and the 'how'. This combination provides a more holistic understanding of country-specific contexts with increased validity and is continually optimized to help identify potential risk mitigation options and intervention strategies.

***Protocol Standardization and Framework Development to Improve Scientific Rigor***

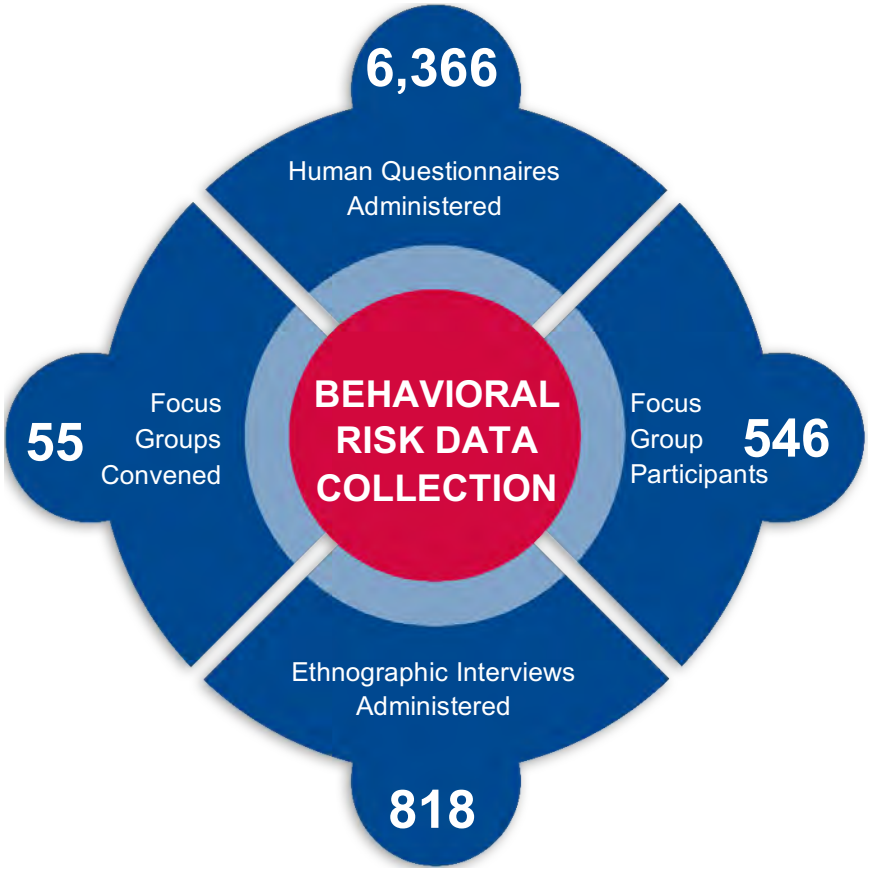
This year, to reduce bias throughout behavioral risk activities, PREDICT standardized protocols and developed frameworks and tools to improve scientific rigor across data collection and analysis, including:

- A universal qualitative codebook to facilitate multi-country data analysis
- Refined qualitative instruments with intervention-focused probes
- A roadmap for intervention development based on risk and protective factors relevant to knowledge/beliefs, attitudes, skills, and behaviors, couched within a program evaluation 'logic model' framework to facilitate program development and evaluation of desired processes and outcomes
- A template for study design delineation
- Development of a framework for integrating local and international feedback into iterative intervention recommendations.

***Leveraging Behavioral Risk Data at High-risk Interfaces***

- PREDICT's standardized protocols and frameworks were used to ensure rigor in data collection
- This data collection was conducted at high-risk interfaces in 81% of countries
- Behavioral risk data collected through FY 2017 is summarized in *Figure 2.*

*Figure 2. Summary of Behavioral Risk Data Collection*




## Identifying Potential Intervention Points

### *Integrating Behavioral Data into Ecological and Biological Risk Characterization*

This year, PREDICT conducted preliminary analyses of behavioral qualitative data to identify indicators of high-risk contact. Emergent trends from the data warranting further in-depth investigation include:

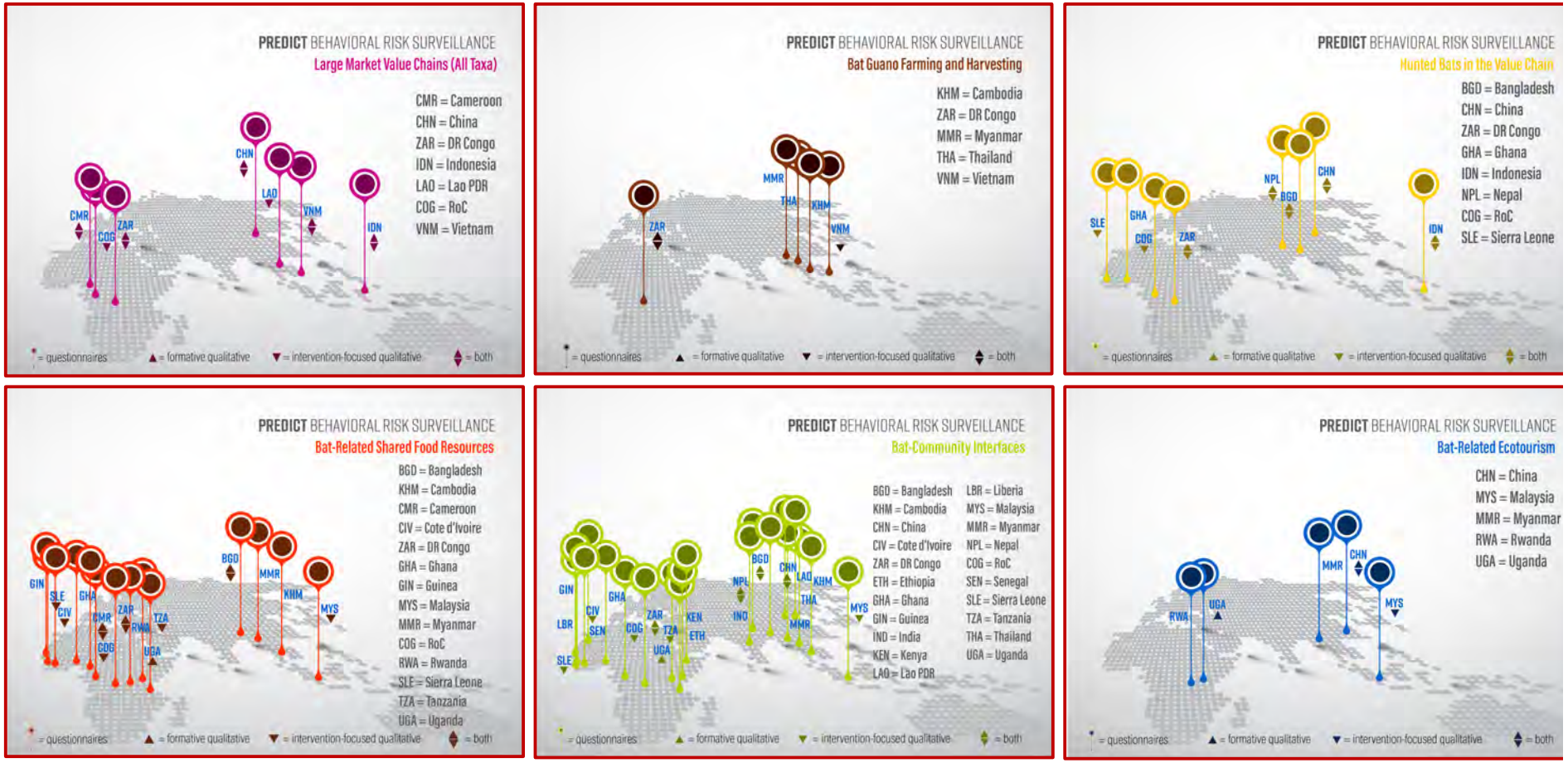
- Large market value chains
- Bat-related interfaces, such as:
  - Bat guano farming/harvesting
  - Hunted bats in the value chain
  - Shared food resources
  - Bat-community interfaces
  - Ecotourism

Bat-related interfaces warrant particular attention given the connection between bats and pandemics, such as SARS and Ebola. In addition, PREDICT detected numerous viruses in bats at high-risk interfaces, including coronaviruses, paramyxoviruses, and influenza viruses. PREDICT also has the potential to make a significant contribution to the prevention of bat-related zoonotic pandemics by recognizing and communicating approaches to live safely and humanely with bats.

Identification of potential intervention points also progressed through collaborative work among the PREDICT behavioral risk surveillance, modeling and analytics, and ecological and biological surveillance teams. Together, the combined team prioritized analytical methods for intervention point identification through data modeling, similarity analyses, and dynamic systems modeling scenario creation.

***Figure 3. Topics for In-Depth Investigation, by Country***

The global PREDICT-2 team is conducting in-depth qualitative research on risk reduction intervention strategies relevant to targeted country-specific interfaces. This tailored approach, largely informed by emergent trends from preliminary analysis of PREDICT-2 data, will facilitate the design and selection of appropriate, impactful, and sustainable interventions.



***Targeting High-risk Behaviors for In-depth Study and Advising on Interventions***

This year, we also began in-depth investigations into the targeted high-risk behaviors. Countries conducting in-depth investigations by topic are shown in *Figure 3*. Early in-depth investigations in West Africa on the bat-community interface revealed community-level desires to better understand strategies for living safely with bats. PREDICT worked in partnership with local and international stakeholders to assess means for communicating these messages and developed a menu of communication channels, or modes, for the implementation of a community-level communication campaign.

Based on further discussion with local level staff and community members, we determined the most suitable channel of communication was a picture book that effectively addresses a low literacy community and that can be narrated by a trusted community leader. The book highlights ways that communities can live safely and humanely in concert with bats.

PREDICT's global-level subject matter experts developed technical content for the picture book and a strategy was designed in conjunction with local and international stakeholders to implement the communication campaign. Roll out is expected in FY 2018. Excerpts from the picture book can be found in *Figure 4*.

## 2016-2017 Behavioral Risk Team Products

- 2-page behavioral risk in-depth investigation information sheet
- Behavioral risk intervention literature review database
- Qualitative data collection instruments with refined intervention-focused probes
- Enhanced training materials on: Ethics in Human Subjects Research; Questionnaire Administration; Data Entry using digital EIDITH and hardcopy bubble forms; Human Syndromic and Community Surveillance; and Qualitative Research
- Communication campaign picture book, "Living Safely with Bats" (Figure 4 below)

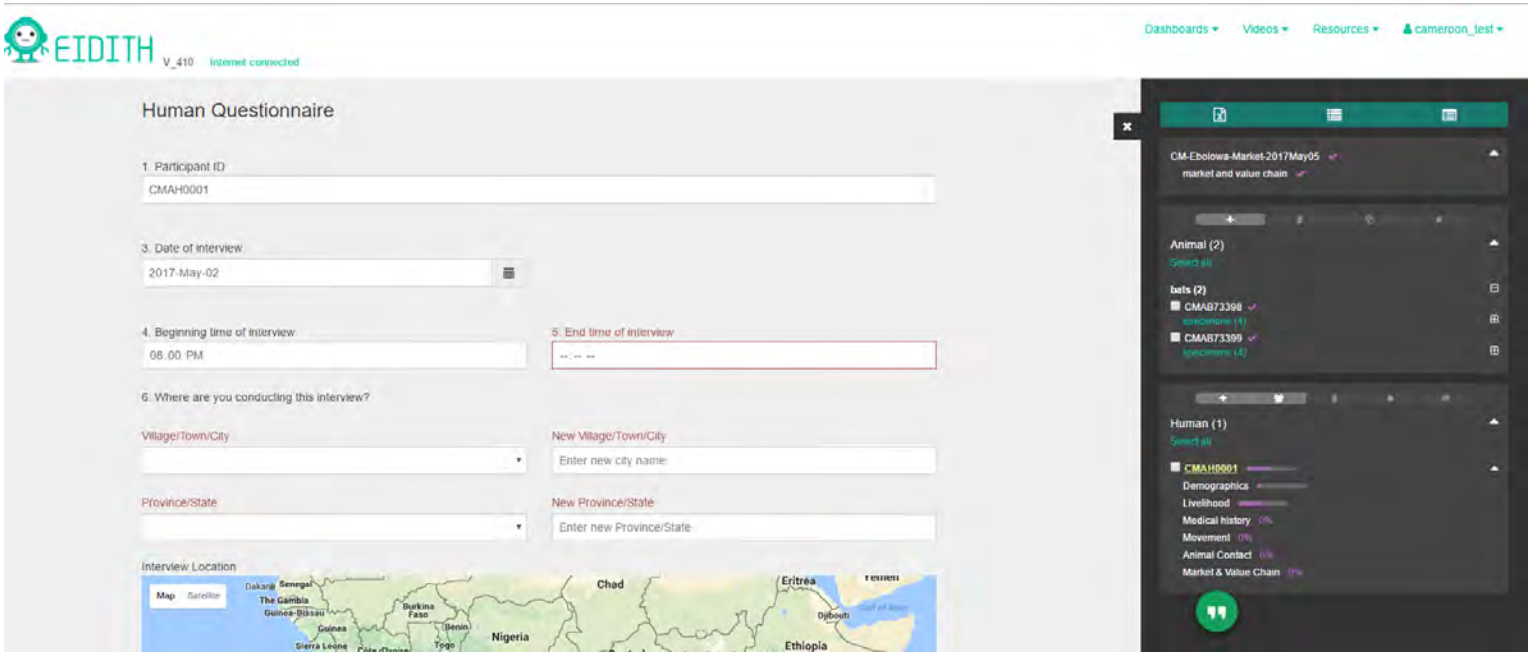
***Figure 4. Excerpts from "Living Safely with Bats"***

Living Safely with Bats
Bats are an Essential Part of our Ecosystem
Bats also play an important role in keeping us and our ecosystem healthy by pollinating flowering plants and by eating insects such as moths and beetles that damage crops.
Ways to Live Safely with Bats
Bats have been connected to viruses like rabies and others that cause diseases in people. Killing or disturbing the natural habitat of bats, however, can worsen the spread of disease so it's best not to hunt, kill or eat bats.

## Improving Global Surveillance Networks

### Strengthening One Health data platforms

The Emerging Infectious Disease Information and Technology Hub (EIDITH) *Surveillance Data Collection Application* was continually optimized to improve efficiency and scope and for integration with EPT-2 Monitoring and Evaluation indictors for improved data capture, quality assurance, and reporting functionality. These improvements included the development of additional tools for uploading large batches of animal, sample, specimen, and test result data using Microsoft Excel templates. Morphometric data collection fields for all taxa groups were also added to improve data completeness, and web application forms were added to report serological test results. A *Country Indicator Report* was developed to assist the in-country teams and global leads with tracking data and progress of submissions, and additional community engagement fields were added to the EIDITH event form for improved monitoring and evaluation

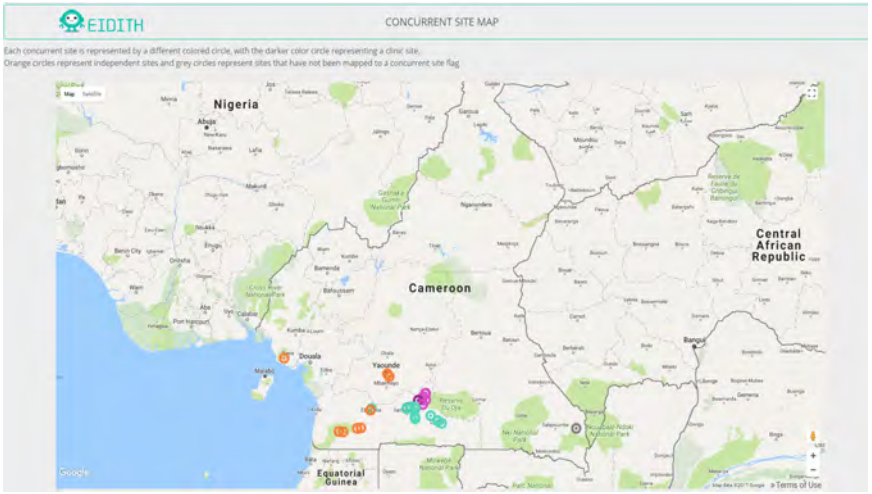


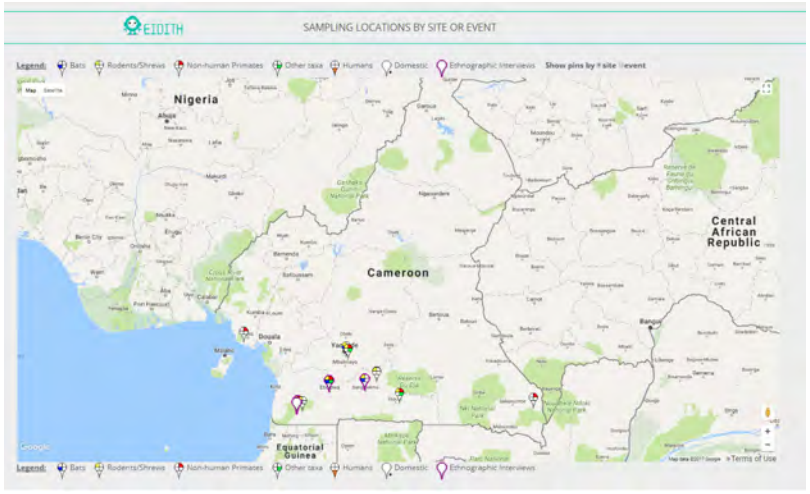
*EIDITH's newly improved application for entering data from human surveillance and behavioral risk activities.*

To enable paper-based data collection and rapid digitization in situations for which digital data collection is not optimal, optical mark recognition (bubble) forms were created. Human questionnaire bubble forms specifically for use in behavioral risk investigations for the Ebola Host Project were also developed and operationalized during this period.

A new data editing feature was added to the EIDITH application. The application now performs a variety of checks before data can be uploaded. For example, the human questionnaire interview dates must fall within the event period, resulting in cleaner data in the EIDITH database.

A new mapping feature was added to our internal and secure system to assist PREDICT country teams with surveillance planning. Three new maps can be instantly created that show sampling by site, type, and event.

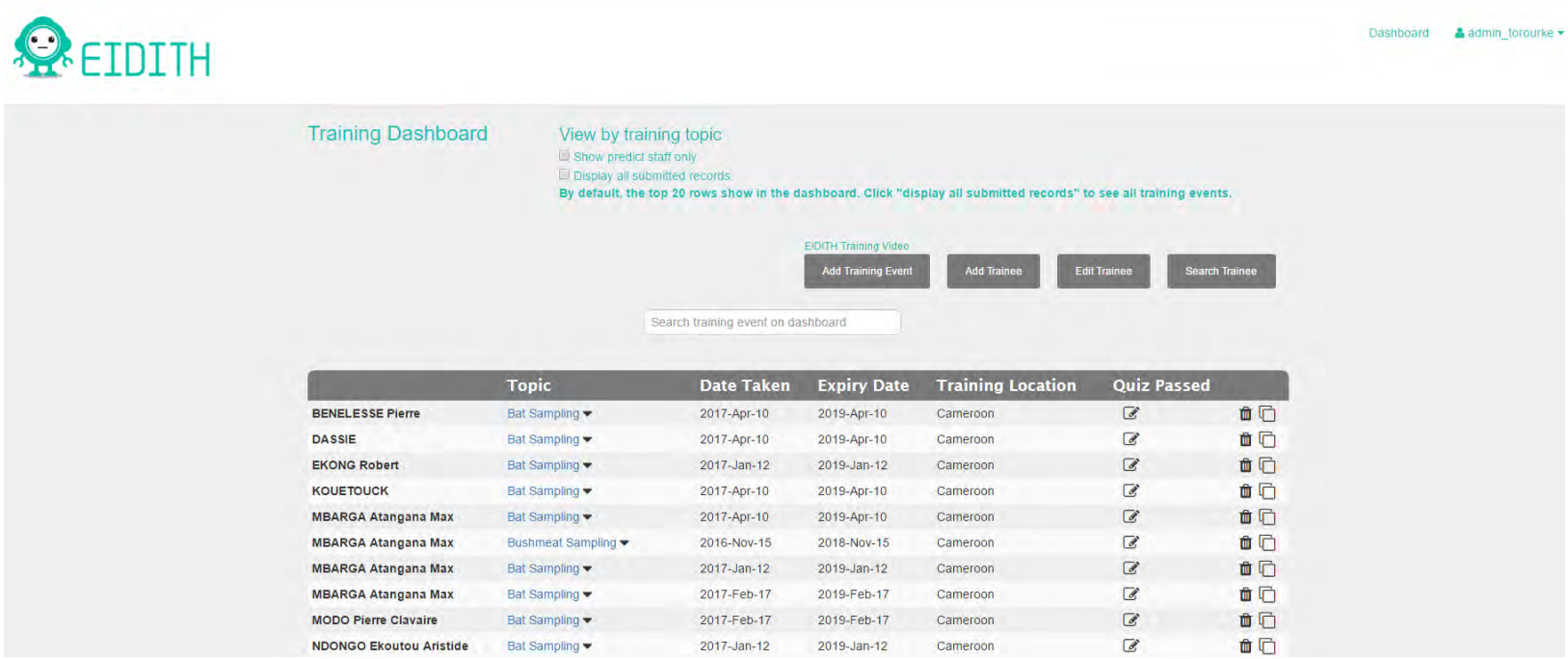

EIDITH
CONCURRENT SITE MAP
Each concurrent site is represented by a different colored circle, with the darker color circle representing a clinic site.
Orange circles represent independent sites and grey circles represent sites that have not been mapped to a concurrent site flag
Nigeria
Cameroon
Central African Republic
Equatorial Guinea
Douala
Yaounde
Bangui
Terms of Use




*A screenshot of EIDITH's new concurrent sampling map displaying the current site definitions for a country (left)*
*A screenshot of EIDITH's new sampling site map displaying the locations and types of samples collected, including ethnographic interviews (right)*

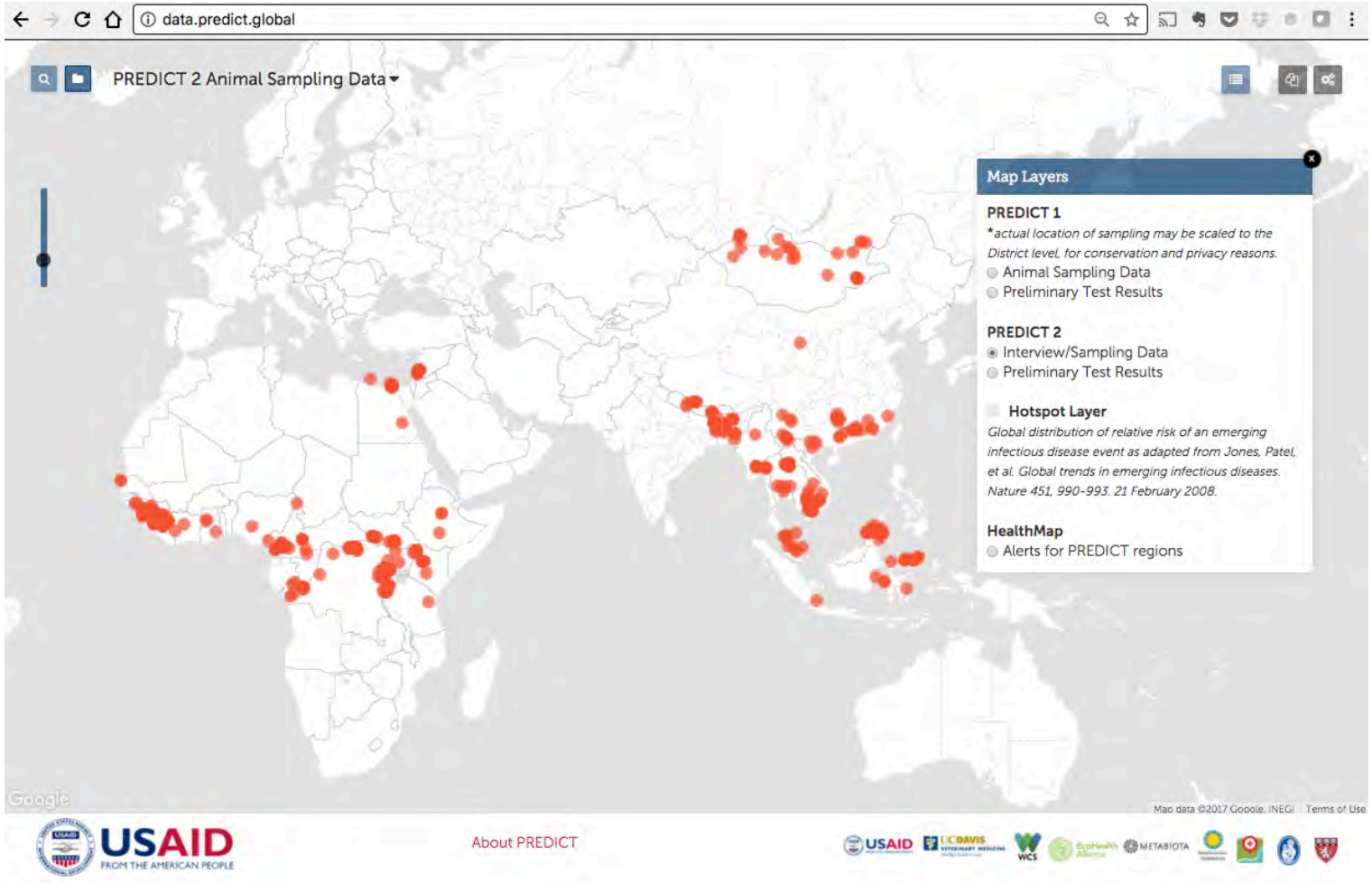
In collaboration with the Behavior Risk team, the *Behavioral Application* was developed and released allowing behavioral data from qualitative research activities to be integrated with quantitative surveillance data. This application serves to collect metadata from ethnographic interviews and focus groups and enables teams to upload and archive transcripts. All data links with surveillance sites and events, improving access to the diversity of data collected by our One Health teams for use in mixed methods analysis.

To support the Capacity Strengthening team with the monitoring of project trainings, new forms for tracking the status of trainees were added to the EIDITH *Training Application*. These forms improve data entry and the accuracy of reporting on PREDICT training activities, and allow managers the capability to view trainee status to ensure all staff are adequately trained for planned activities. =


EIDITH
Dashboard
admin_torourke
Training Dashboard
View by training topic
Show predict staff only
Display all submitted records
By default, the top 20 rows show in the dashboard. Click "display all submitted records" to see all training events.
EIDITH Training Video
Add Training Event
Add Trainee
Edit Trainee
Search Trainee
Search training event on dashboard
Topic
Date Taken
Expiry Date
Training Location
Quiz Passed
BENELESSE Pierre Bat Sampling 2017-Apr-10 2019-Apr-10 Cameroon
DASSIE Bat Sampling 2017-Apr-10 2019-Apr-10 Cameroon
EKONG Robert Bat Sampling 2017-Jan-12 2019-Jan-12 Cameroon
KOUETOUCK Bat Sampling 2017-Apr-10 2019-Apr-10 Cameroon
MBARGA Atangana Max Bat Sampling 2017-Apr-10 2019-Apr-10 Cameroon
MBARGA Atangana Max Bushmeat Sampling 2016-Nov-15 2018-Nov-15 Cameroon
MBARGA Atangana Max Bat Sampling 2017-Jan-12 2019-Jan-12 Cameroon
MBARGA Atangana Max Bat Sampling 2017-Feb-17 2019-Feb-17 Cameroon
MODO Pierre Clavaire Bat Sampling 2017-Feb-17 2019-Feb-17 Cameroon
NDONGO Ekoutou Aristide Bat Sampling 2017-Jan-12 2019-Jan-12 Cameroon

*A screenshot of the training app dashboard, which allows improved monitoring of the status of all PREDICT trainees and staff*

In addition, PREDICT-2 surveillance and test result data were incorporated into the project's HeathMap-hosted public site, available online at http://data.predict.global. Plans were also made to display the Modeling and Analytics' team's updated hotspots layer (See Publications and Products) as well as to display a visualization of PREDICT training data.


data.predict.global
PREDICT 2 Animal Sampling Data
Map Layers
PREDICT 1
*actual location of sampling may be scaled to the District level, for conservation and privacy reasons.
Animal Sampling Data
Preliminary Test Results
PREDICT 2
Interview/Sampling Data
Preliminary Test Results
Hotspot Layer
Global distribution of relative risk of an emerging infectious disease event as adapted from Jones, Patel, et al. Global trends in emerging infectious diseases. Nature 451, 990-993. 21 February 2008.
HealthMap
Alerts for PREDICT regions
Google
Map data ©2017 Google, INEGI
Terms of Use
USAID
FROM THE AMERICAN PEOPLE
About PREDICT

*A screenshot of PREDICT's public site available at http://data.predict.global*

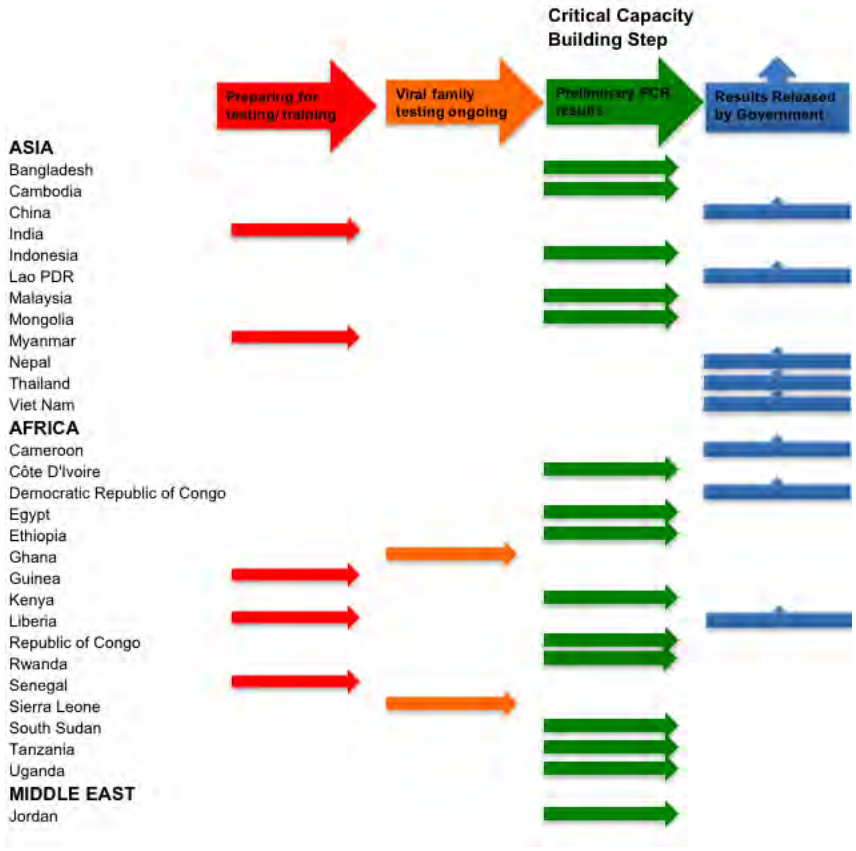
# Viral Detection and Lab Implementation

## Laboratory capacity building

PREDICT is currently targeting 63 laboratories for training and testing for priority viral families (Corona, Paramyxo, Filo, Influenza, Flavi viral families), 24 labs gained a one or two step increase in capacity: 15 labs began training/preparing for testing, 22 labs produced preliminary results, nine labs submitted sequence results for interpretation, government results reports have been prepared for seven countries, and reports have been presented to nine countries. There is a total of 48 labs currently testing or preparing to test for viral families across Asia and Africa.

*The PREDICT/Sierra Leone laboratory team based at the University of Makeni and technicians from the Central Animal Laboratory during viral detection training with the PREDICT lab manager and global lead from UC Davis Photo: PREDICT/UC Davis.*

## Summary of major milestones in laboratory testing by country



## PREDICT viral interpretation results*

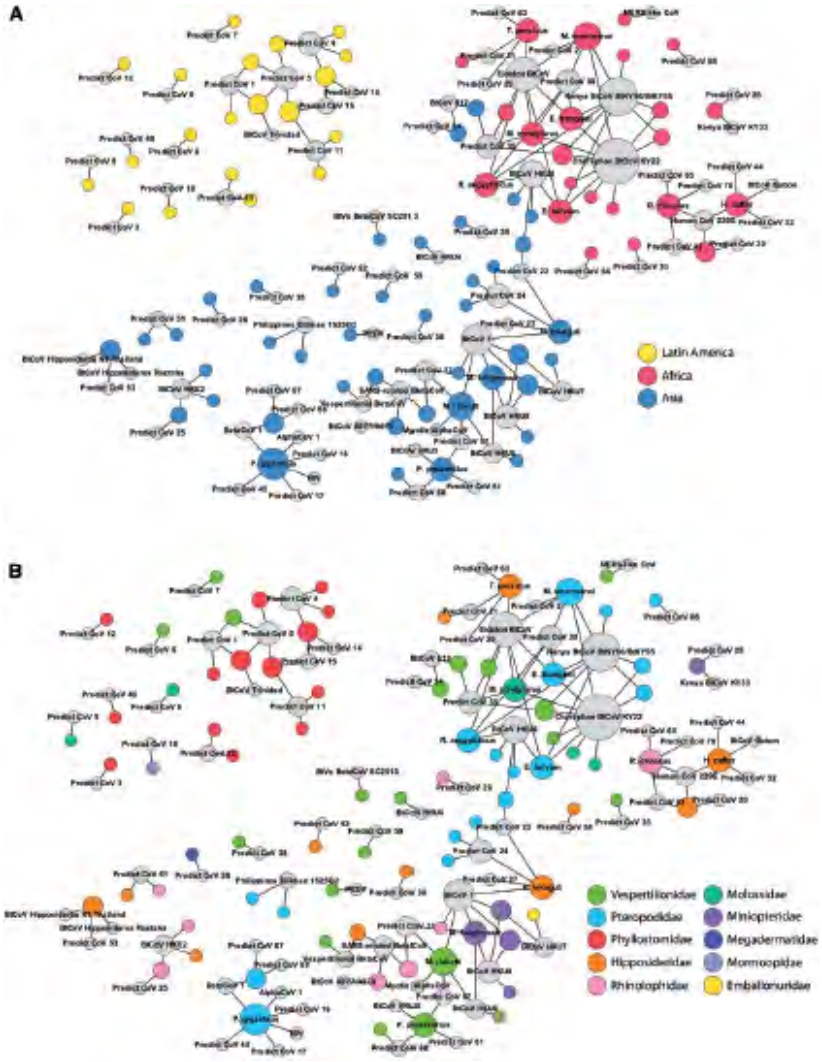
| Viral Family | Number of known viruses found in P1 | Number of novel viruses found in P1 | Number of additional known viruses found in P2 | Number of additional novel viruses found in P2 | Total |
|---|---|---|---|---|---|
| Coronavirus | 31 | 69 | 9 | 11 | 120 |
| Paramyxovirus | 12 | 74 | 4 | 22 | 112 |
| Filovirus | 0 | 0 | 0 | 0 | 0 |
| Influenza virus | 8 | 0 | 0 | 0 | 8 |
| Flavivirus | 3 | 5 | 1 | 0 | 9 |
| Hantavirus | 4 | 3 | 1 | 0 | 8 |
| Rhabdovirus | 0 | 31 | 0 | 3 | 34 |

**Some findings not yet approved for release; data for other viral families detected during PREDICT-1 not shown*

## New findings

**Global patterns in coronavirus diversity**, published in *Virus Evolution*, 2017 Jan; 3(1): https://doi.org/10.1093/ve/vex012

*Summary of findings:* Since the emergence of Severe Acute Respiratory Syndrome Coronavirus (SARS-CoV) and Middle East Respiratory Syndrome Coronavirus (MERS-CoV), it has become increasingly clear that bats are important reservoirs of CoVs. Despite this fact, only 6% of all CoV sequences in GenBank are from bats. The remaining 94% largely consist of known pathogens of public health or agricultural significance, indicating that current research effort is heavily biased towards describing known diseases rather than the 'pre-emergent' diversity in bats. Our study addresses this critical gap and focuses on resource poor countries where the risk of zoonotic emergence is believed to be highest. We surveyed the diversity of CoVs in multiple host taxa from twenty countries to explore the factors driving viral diversity at a global scale. We identified sequences representing 100 discrete phylogenetic clusters, ninety-one of which were found in bats, and used ecological and epidemiologic analyses to show that patterns of CoV diversity correlate with those of bat diversity. This cements bats as the major evolutionary reservoirs and ecological drivers of CoV diversity. Co-phylogenetic reconciliation analysis was also used to show that host switching has contributed to CoV evolution, and a preliminary analysis suggests that regional variation exists in the dynamics of this process. Overall our study represents a model for exploring global viral diversity and advances our fundamental understanding of CoV biodiversity and the potential risk factors associated with zoonotic emergence.

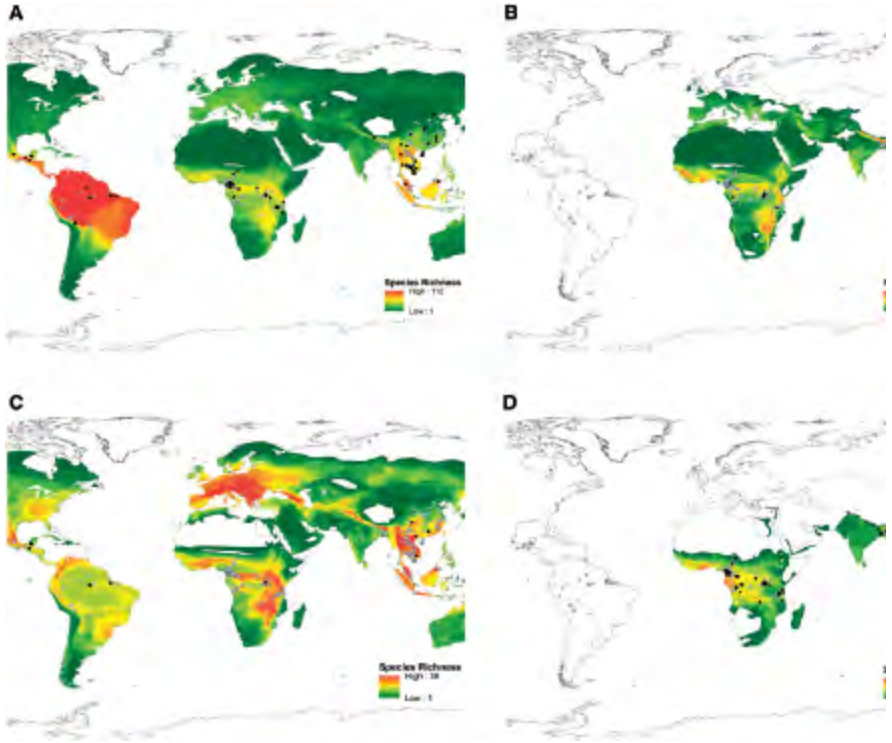



**Network model showing the connection of CoVs and their hosts.**

Viral sequence clusters (colored grey) are connected to host species, either by region (Panel A) or family (Panel B). Viral and host and communities separate almost entirely by region; only Africa and Asia are connected by two shared viruses (HKU9 and PREDICT_CoV-35) found in species from both continents. Networks also show that viruses appear to be shared by multiple host families in Africa and Asia, while being more restricted to a single family in Latin America.

**Viral diversity 'hotspot' maps.**

Panel A shows the potential hotspots for CoVs based on the distribution of bats worldwide. Location of alpha CoV sequences from this study are shown in black and beta CoV sequences in blue, indicating there is no geographical bias based on viral genus (i.e. alpha and beta CoVs are equally likely to be found in all regions). Some viral sub-clades were associated with particular bat families, and the spatial distribution data of all species belonging to these families were plotted to indicate the potential hotspots of viral diversity (richness) for these sub-clades.
Panel B indicates the potential distribution of 2b CoVs based on the distribution of rhinolphus and hipposideros bats. Locations of 2b-positive animals identified in this study are indicated in black, and correlate with areas of high species richness (for these families). CoV-positive animals for other sub-clades shown in light blue.
Panel C indicates the potential distribution of 2c CoVs based on the distribution of vespertilionid bats. Locations of 2c-positive animals identified in this study are indicated in black. This map suggests that there are hotspots of 2c diversity in regions not covered in this study (e.g. Europe).
Panel D indicates the potential distribution of 2d viruses based on the distribution of pteropid bats. The map suggests these viruses may have a more limited distribution, compared with viruses of other sub-clades. Locations of 2d-positive animals identified in this study are shown in black.

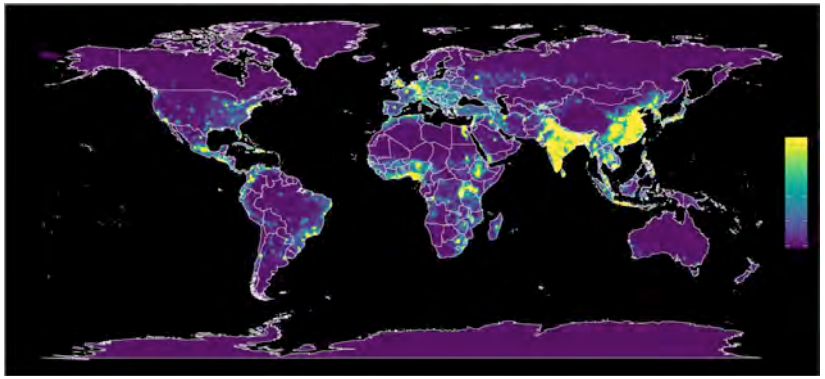


## Tools in development

- **Coronaviruses**: Completed twelve full-genome sequences (others ongoing) for PREDICT corona viruses to: 1) understand their evolution and 2) develop primer sets for in-country PCR characterization of spike proteins.
- **Paramyxoviruses**: Continued development of a reverse genetics system for further characterization of paramyxoviruses to evaluate viral pathogenicity and host range; sequenced the genomes of seven paramyxovirus detected, others are ongoing.
- **Ebola Serologic Assay**: Completed development - Indirect ELISA using recombinant full-length Glycoprotein to screen (group assays to detect exposure to all Ebola species); completed development - peptide ELISA to distinguish between Ebola species (Ebola species-specific assay).
- **Refining our deep-sequencing approach**: Continuing to compare results of high throughput sequencing using unbiased sequencing and VircapSeq-VERT to identify when each tool is preferable for use by host species and virus.
- **Host cell receptors**: Assessing the binding of Ebola virus to different bat NPC1 phenotypes.

## Modeling and Analytics

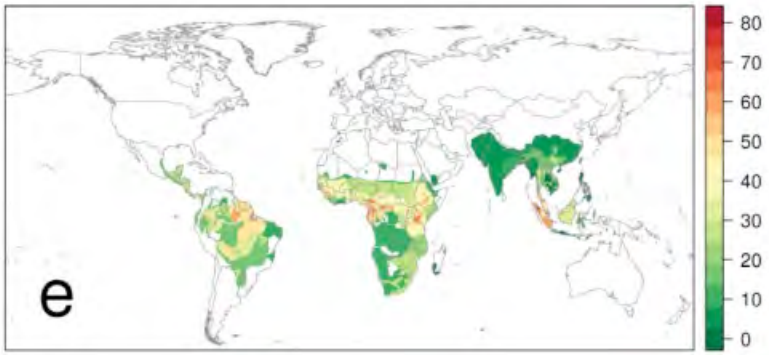
### Major highlights and successes



*Map of the relative risk of a new emerging zoonotic disease. Yellow = highest, purple = lowest. This map is corrected for global variations in reporting effort to give a true measure of risk.*

Version 2.0 of the Emerging Infectious Disease (EID) hotspots maps for emerging zoonoses was published (*Allen et al.*), with a completely new analysis identifying where the next EID will most likely originate (see map above). The new map replaces the Jones *et al.* hotspots map from 2008, and the study was published in the October 2017 issue of *Nature Communications*. Outputs of these models and code are publicly available on GitHub, allowing researchers around the world to access this important information. We are now working on the next iteration of the hotspots map based on projections of how drivers (e.g. land-use change) will alter EID risk in the future.

In addition, the PREDICT Modeling & Analytics (M&A) team finalized for public release a new strategy to identify sites that are most likely to have the highest number of unknown high-risk viruses that are yet-to-be-discovered ("missing




*A new map identifying locations on the planet that likely harbor the most zoonotic viruses from primates, including those yet-to-be-discovered.*

zoonoses"). A manuscript (*Olival et al.*) was published in *Nature* in June 2017 (see map above). This work was highlighted by international media outlets, including *BBC*, *CNN*, *The Economist*, *El Mundo*, and *The Wall Street Journal*. The work was presented to the scientific community at several conferences, including the 2017 Bat-Borne Infectious Disease Symposium in Fort Collins, Colorado, and as part of a workshop on modeling techniques at the Ecological Society of America Conference on August 5, 2017.

The PREDICT team developed a software package to allow PREDICT in-country and other partners to analyze PREDICT data more easily and rapidly. The EIDITH R Package includes documentation, training modules, and even mock datasets to explore. All issues of data security were ensured by the project information management (IM) and M&A teams, whereby access to data is limited via an individual's project-secured login credentials.

PREDICT was well represented at the International Meeting on Emerging Diseases and Surveillance (IMED) in Vienna, Austria on November 4-7, 2016. Presentations included the

plenary “Evidence for a Risk-Based Strategy to Detect Viral Spillover and Spread”, "Identifying the next Zika: An analysis of zoonotic potential in Flaviviridae"; "Global correlates of emerging zoonoses: Anthropogenic, environmental, and biodiversity risk factors"; and “The Global Virome Project."
At a workshop in Ethiopia, with FAO partners, PREDICT M&A presented an overview and first results of Africa Sustainable Livestock 2050 modeling on February 20-24, 2017.

PREDICT organized Modeling & Analytics workshops with participants from USAID and FAO. A workshop, was held in Indonesia from September 4-6, 2017(see picture above) and in Nepal from March 14, 2017, which included an introduction to R and modeling.  Future workshops will include Advanced R, GIS, and Economics.

PREDICT collaborated with the World Bank to organize the Economics of One Health workshop January 30 - February 2, 2017. The team provided modeling expertise to promote cross-sectoral understanding of One Health and propose methodology for economic evaluation of One Health approaches (see picture at top left).

As part of continuing efforts to strengthen global capacity for characterizing risks of zoonotic disease emergence, the PREDICT Modeling & Analytics team hosted and mentored an

international fellow from Ghana to spatially describe habitat suitability and zoonotic spillover risk of *Eidolon helvum* bats. This opportunity, along with the fellow’s additional PREDICT training as a PREDICT/Ghana team member, helped him secure a new position as a Professor at the University of Ghana where he will be training tomorrow’s One Health workforce, a major capacity strengthening success story highlighting PREDICT’s contribution to workforce development.

## Progress and new model development

### Advancing tools for African Sustainable Livestock (ASL) 2050

The team worked with EPT-2 partners at FAO to develop a hotspots analysis for the ASL 2050 project. This allows us to

identify how proposed changes to livestock production in Africa will affect the risk of zoonotic disease emergence. Analyses show important regional differences in the drivers of EIDs that can be used to help policy goals.

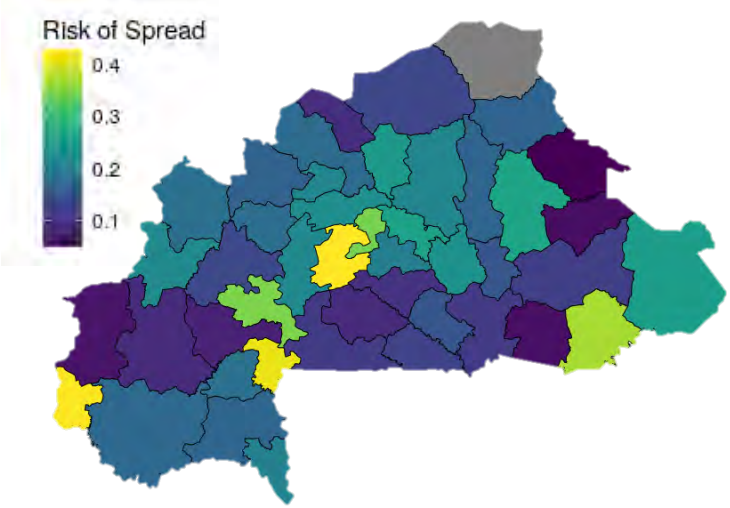
The team developed a dynamic model workflow to analyze how intensification of poultry production and different surveillance and control policies (e.g., culling) will impact avian influenza risk in the Africa region. The team used their adapted model combined with poultry density data from household surveys (FAO) to simulate avian influenza outbreaks across Burkina Faso, identifying provinces of greater relative risk for avian influenza outbreaks. These maps were sent for presentation and feedback from FAO Regional meetings in October 2017.

**Assessment of zoonotic spillover risk across a disturbance gradient**

We completed an analysis of how host biodiversity responds to land use change (i.e. deforestation) using data from PREDICT's DEEP FOREST sites in Malaysia, with ongoing analyses for Uganda and Brazil. We are currently analyzing viral diversity across the land use gradient, exploring how novel host communities impact pathogen community structure. This work was presented at the Convention of Biological Diversity in December 2016 and the International Congress for Conservation Biology in July 2017, showcasing how PREDICT aligns with the Sustainable Development Goals of the United Nations.

**Exploring long-term trends in pandemic risk and novel strategies to discover new viruses**

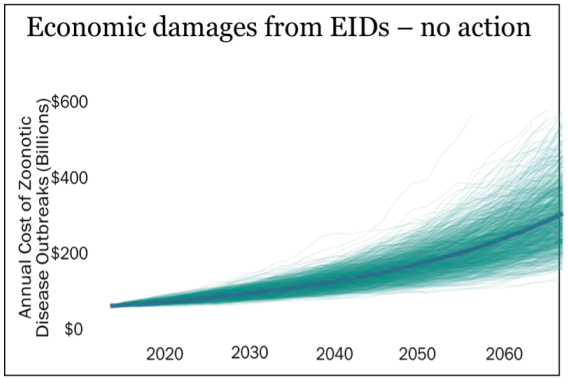
To assess long-term trends in pandemic risk, we calculated expected global economic damages from EIDs over the next




*Analysis of the relative risk of sustained avian influenza epidemic in Burkina Faso provinces based on simulations of large-scale networks of interconnected household, market, and commercial farm poultry flocks*

50 years (see figure below) using data from the Emerging Infectious Disease Repository (EIDR), which is partially funded by PREDICT.

*Analysis of the likely economic cost of emerging infectious diseases over the next 50 years if no coordinated global action is taken. Total cost is $3.6 trillion. Investing in a control program that reduces the number of events or size of events by only 5% gives a 96:1 return on investment.*



Better estimates of the likely number of unknown zoonoses in wildlife will help refine programs to combat this growing cost. We estimated the number of currently undiscovered 'missing zoonoses' in mammals globally, by extending the previous analysis published in *Nature (June 2017)* from ~750 mammal host species to all terrestrial mammals (5304 species).

The PREDICT M&A team developed a flexible modeling approach that can be used nationally, regionally, or globally to identify sites for optimal targeting to discover these viruses. Using data on waterbirds and mammals, we maximized regions with unique biodiversity while minimizing sampling costs and site overlap. We identified a minimal selection of 108 efficient wildlife sampling sites for viral discovery. This approach was presented at the International Congress of Ecology (INTECOL) in China on August 24, 2017.

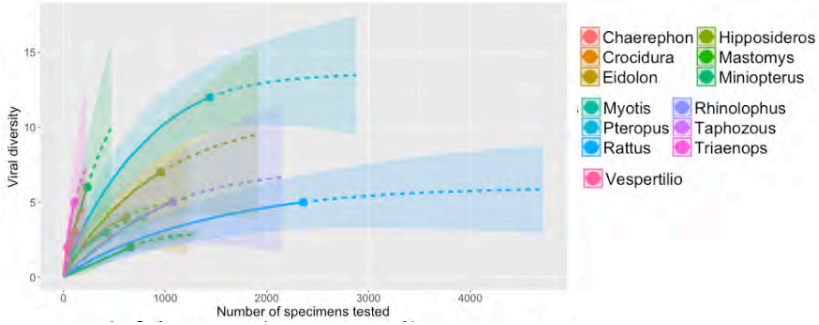
Following the recent PREDICT discovery of a novel virus from bats causing die-offs in pigs, the M&A team began a collaborative project with PREDICT scientists in China to model viral spread. The goals are to understand how the virus --Swine Acute Diarrheal Syndrome coronavirus (SADS-CoV) -- spreads within and among pig farms and to identify outbreaks based on these patterns so that we can assess how widespread it is within China.

**Cross-team integration of behavioral risk, surveillance, and modeling**

The M&A team is working collaboratively with the Behavioral Risk and Surveillance teams to identify potential intervention strategies targeting high-risk bat-to-human and bat-to-livestock transmission interfaces, as well as wildlife trade issues generally. The team has identified 16 high-risk interfaces for which to analyze and model potential intervention strategies, including:

- Ecological analyses of bat overlap with orchards, swine, and palm sap to identify risk areas
- Risk ranking of caves based on local bat species, tourism trends, and intensity of guano harvester interactions
- Assessing the risk of medium and large market value chains based on animal biodiversity, potential for viral sharing, and public attitudes of intervention strategies

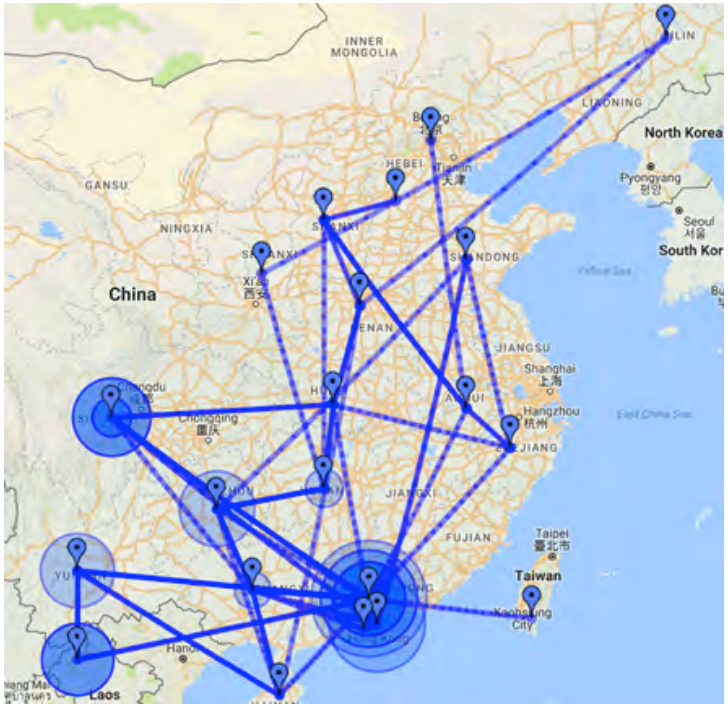
## Analyzing PREDICT-1 data to support surveillance




*A viral accumulation curve for paramyxoviruses that is part of an interactive tool developed for PREDICT staff to enable exploration of viral discovery data and compare the efficacy of different sampling protocols.*

Using PREDICT-1 data, we developed an interactive *viral accumulation curve* tool and searchable table to allow in-country staff to explore viral discovery data and compare the efficacy of different sampling protocols.

To identify the risk interfaces that produce the most novel viruses in our sampling, we designed a power analysis using viral detection rates and animal sampling distributions from PREDICT-1.




*The spatial spread of Betacoronaviruses, showing the common ancestor for most viral lineages is located in Hong Kong and Guangdong.*

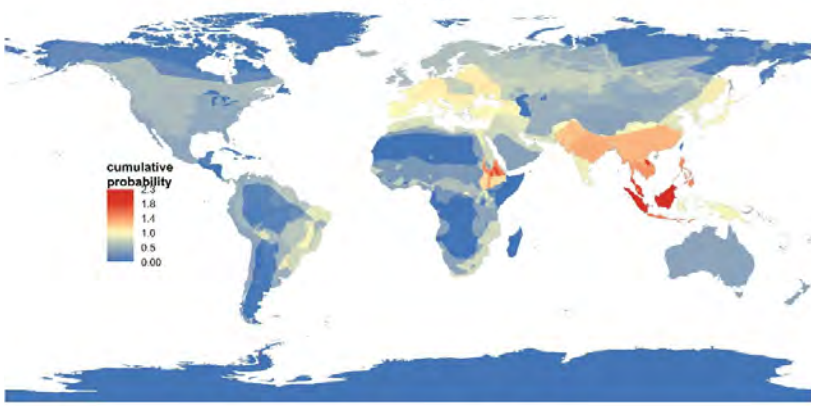
In order to understand which PREDICT coronaviruses are more likely to jump from one host species to another (i.e. their potential to infect people), we analyzed host and viral relatedness (phylogenies) data from China. This includes the use of new tools to reconstruct where and in which species bat coronaviruses originated. These statistical approaches allow us to infer coronavirus transmission between bat taxa and geographic regions and can be applied to other host-virus systems.

We compiled PREDICT-1 bat virus data with literature information to test the role of cave roosting behavior in driving viral sharing between different bat species. This work was published in the open-access biodiversity journal *Diversity* and our novel database on bat roosting behavior is publicly available.

Additionally, we designed a way to help rank novel viruses by their zoonotic potential and calculated the “Phylogenetic Host Breadth” (genetic diversity of all known hosts for a virus) for all PREDICT-1 viruses based on observed host associations. Finally, to assess most productive timing for sample collection, we analyzed seasonal patterns in viral detection in bats from PREDICT-1 data, including integration of life history data and global climate datasets. For instance, we have found that optimal time to sample *Pteropus medius* for viral shedding is mid-August. Intervention strategies could be targeted to such peak risk times.

## Characterizing wildlife hosts of zoonotic flaviviruses to predict zoonotic reservoir hosts and inform surveillance activities

Surveillance activities to recognize important animal reservoirs for human diseases are hampered by incomplete geographic coverage. This flavivirus-specifiic modeling activity seeks to identify likely sylvatic hosts of flaviviruses beyond the wild animal hosts discovered to date (based on published literature and data from PREDICT-1). Data have been collected on all known and suspected flavivirus hosts and vectors, and we used a gradient boosted regression tree model to predict hosts with a high probability of serving as a host for different flaviviruses, based on their ecological traits, behavior, and interactions with known flavivirus vectors. Model




*Geographic regions with high predicted numbers of flaviviral vertebrate hosts.*

results were used to prioritize animal species with samples collected in PREDICT-1 for additional testing using yellow fever and Zika virus-specific PCR tests. Modelling predictions also evaluate differences in flavivirus predilictions for different hosts and identify geographic areas with wildlife hosts that have a high probability of enabling sylvatic cycles of flavivirus transmission that can potentiate viral spread and continued spillover to human populations.

## New products and cutting-edge insights

In addition to the EIDITH R software package highlighted above, the M&A team developed another R package -- fasterize -- to improve and accelerate time-consuming risk analyses and for implementing high-speed algorithms for geospatial analyses. This tool is publicly available on GitHub and will be of value to researchers globally doing spatial analyses.

To better understand the diversity of viruses in birds, we developed a preliminary model examining avian life-history traits and viral richness in birds using data from 1907 avian-virus associations from the literature for 929 bird species and 142 viruses.

We designed new approach to refine a global model to predict the number of zoonotic viruses per mammalian host species. This activity used a novel geographic cross-validation procedure for evaluating spatial models by excluding species by zoogeographic region.

We updated a database of viral decay/survival studies to include 272 publications to conduct an analysis of the risk of viruses surviving on surfaces and in the environment. These data will be made public once compiled.

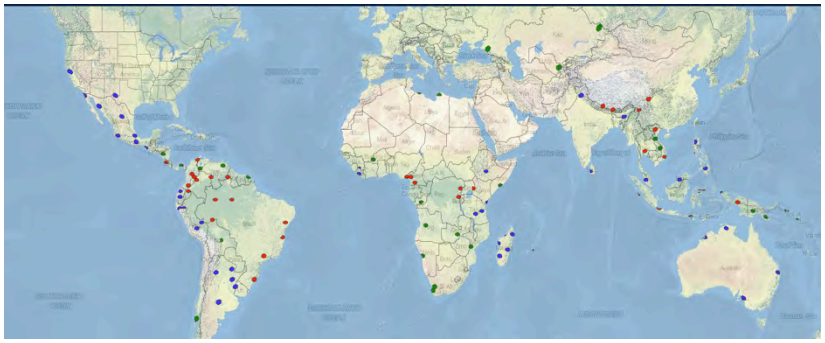
We are systematically assessing antimicrobial resistance (AMR) events in humans. We have systematically screened 23,770 publications and extracting relevant data. This information will be used to create a global hotspots analysis of AMR events in people to identify the ecological and demographic factors that spatially correlate with AMR emergence.

After the **emergence of Zika virus**, we developed a series of analyses to assess the zoonotic potential of other, less studied flaviviruses:

- Network analysis based on host and vector associations for all known flaviviruses from the literature
- Map of global flavivirus diversity based on mammal and bird host distributions and human case distributions
- Analysis of the characteristics of all known flaviviruses to identify which are more likely to be able infect humans

## Global Virome Project

To estimate the costs and optimize potential sampling sites to enable planning and strategizing for the Global Virome Project, we used spatial analyses which combined maps of mammal and waterbird biodiversity, hotspot risk, 'missing zoonoses' and access costs. This strategy identified 108 global sites (see map below). In addition, we developed and ran an economic model to calculate Return on Investment for a 10-year investment in the Global Virome Project.



*Map of 108 global viral discovery sites for minimal number of efficient, high diversity sites developed for PREDICT and the Global Virome Project.*

## For more information

A full list of PREDICT Modeling and Analytics team products and output is included in the *Monitoring and Evaluation Appendix 1*.

## One Health Partnerships

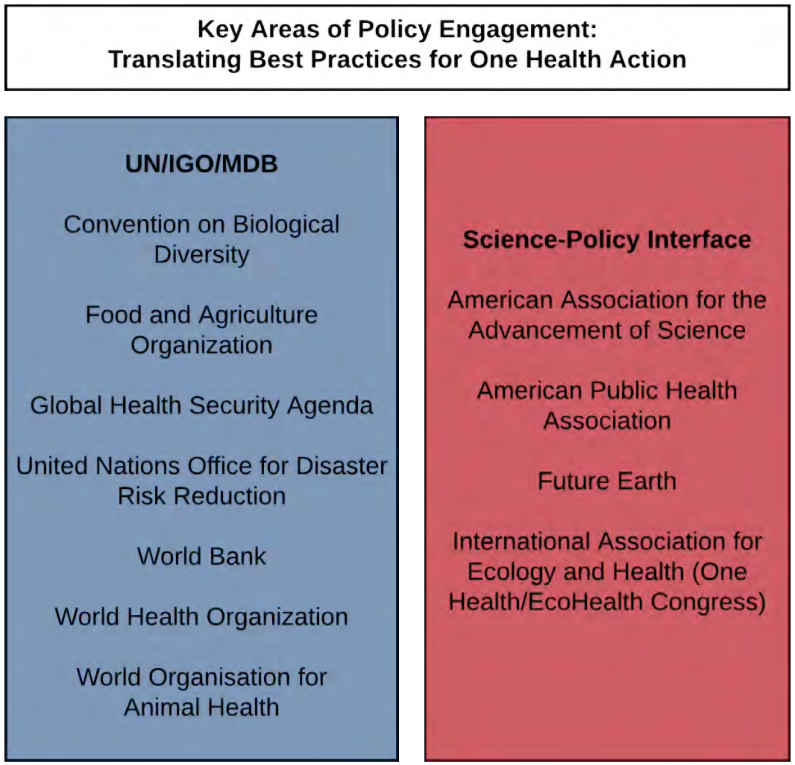
### One Health policy advocacy

To strengthen integration of the environment sector in One Health and health security, we suggested key additions and updates to the World Health Organization (WHO) for their forthcoming guide for national action planning for health security, as well as the WHO Joint External Evaluation tool, to reflect wildlife pathogen surveillance, disease forecasting, and risk management opportunities. We also provided expert guidance on a draft matrix of impacts to health from environmental change and One Health "vignettes" to inform potential actions by the G7.

We prepared a One Health policy statement for the American Public Health Association (APHA), highlighting needs and opportunities for the public health community to advance health security and pandemic prevention and preparedness capacity in the U.S. and globally. The policy statement draws on strategies and lessons learned from PREDICT-2 and was prepared in collaboration with the health focal point from the UN Office for Disaster Risk Reduction (UNISDR). This fills a critical policy gap in the APHA.

### Other highlights and success stories

We developed a One Health outbreak simulation exercise for students, which was piloted with international students from Dartmouth College. The exercise examined an undiagnosed illness (modeled on the 1998-99 emergence of Nipah virus in Malaysia) through the human health, animal health and environment sectors, bringing together information to elucidate the transmission chain and demonstrating the value of multisectoral collaboration via a One Health approach.


Key Areas of Policy Engagement:
Translating Best Practices for One Health Action
UN/IGO/MDB
Convention on Biological Diversity
Food and Agriculture Organization
Global Health Security Agenda
United Nations Office for Disaster Risk Reduction
World Bank
World Health Organization
World Organisation for Animal Health
Science-Policy Interface
American Association for the Advancement of Science
American Public Health Association
Future Earth
International Association for Ecology and Health (One Health/EcoHealth Congress)

Building on global economic analyses in the World Bank's 2012 "People, Pathogens and Our Planet" report, PREDICT partnered with the World Bank and the Network for Evaluation of One Health to hold an expert workshop in February 2017 to

*One Health in Action, a case study booklet released by PREDICT and P&R is available online at: [onehealth.predict.global](onehealth.predict.global)*

examine how to align methods, metrics and data to inform national decision making. Through the workshop, we established a methodology for country-level economic analysis of One Health. These methods are being applied in PREDICT countries, reinforcing overall efforts in collaboration with the World Bank to operationalize One Health and assist countries in determining cost-effective pandemic prevention and preparedness measures.

As part of ongoing investigations to advance our understanding of the value of the One Health approach, we disseminated the One Health data collection form to PREDICT countries. By systematically documenting examples of One Health, we can evaluate its effectiveness and identify best practices for local and national platforms, creating synergies with EPT-2 partner Preparedness and Response (P&R) to maximize benefits generated from One Health approaches. The "One Health in Action" case study booklet highlighting examples was also released by PREDICT with P&R on the first international One Health Day and is available online.

## New publications, products, and policy briefs

This year we produced eight new publications, products and policy briefs.

- "Evaluating One Health: Are we Demonstrating Effectiveness?" in the journal *One Health* (collaboration with P&R).
- "Summarizing US Wildlife Trade with an Eye Toward Assessing the Risk of Infectious Disease Introduction" in *EcoHealth,* reviewing 14 years of import data, including from PREDICT countries, to examine possible zoonotic disease risks.
- "Global Environmental Change and Emerging Infectious Diseases: Macrolevel Drivers and Policy Responses" (book chapter).
- "Avoiding catastrophes: seeking synergies among the public health, environmental protection, and human security sectors" in *The Lancet Global Health* (commentary).
- "Wildlife hosts for OIE-Listed diseases: considerations regarding global wildlife trade and host–pathogen relationships" in *Veterinary Medicine and Science* (Published findings of host-pathogen analysis entitled).
- Post on the *Lancet Global Health* blog on disease drivers and animal vaccination targets to optimize the Coalition for

Epidemic Preparedness innovation (CEPI - with partners from the World Bank, Harvard and OIE: Available online).
- 'One Health in Action' case study booklet (English and French, see above for link).
- A briefing document on the role of environment in One Health and national health security.

## Selected presentations on PREDICT, One Health, zoonotic diseases, and global health security

- Presented on economic consequences of EIDs as well as disease drivers and pathogen surveillance in wildlife and relevant costing items as integral components of national action planning for health security at the WHO Stakeholders Consultation on Planning, Costing and Financing for accelerated IHR implementation and Global Health Security (non-PREDICT).
- Presented at high-level GHSA event held at the State Department.
- Presented on PREDICT approaches and EID risk mitigation at multiple side events at the Convention on Biological Biodiversity (CBD) Thirteenth Conference of the Parties, including dissemination of key messages from the infectious disease chapter of the WHO-CBD State of Knowledge Review on Biodiversity and Human Health. A formal decision was passed reinforcing the value of One Health and recognizing the drivers of EIDs.
- Hosted session on One Health at the AAAS Science Diplomacy conference, presenting on drivers of disease and the economics of One Health.
- Presented on the drivers of disease and the PREDICT project on a Future Earth webinar.
- Presented on PREDICT One Health effectiveness metrics at the EU Network for Evaluation of One Health meeting.
- Presented on policy engagement for One Health, One Health and viral discovery, and organized a symposium on future health at the One Health/EcoHealth Congress.
- Attended the FAO-OIE Global Framework for the progressive control of Transboundary Animal Diseases Steering Committee meeting.
- Attended the OFFLU Steering Committee meeting, presenting on influenza surveillance activities in wild birds.
- Chaired the OIE Working Group on Wildlife Meeting, highlighting new and emerging wildlife disease events and reinforcing the importance of country reporting for wildlife diseases.
- Presented on One Health cost-effectiveness at the American Public Health Association meeting.

# Management and Operations

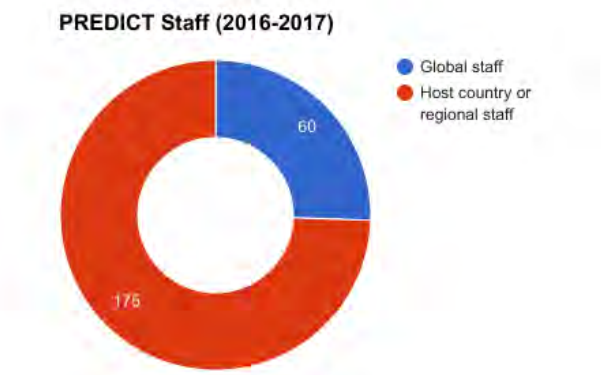
## Highlights and successes

The PREDICT Project held two global team coordination meetings this year, one in Pacifica, California in January and another in September 2017 in New York City. These meetings brought together key personnel and operations team leads to discuss project status, review data, plan for a successful completion of the project, and work with our USIAD senior management team and external advisory panel to strategize for overall project success. The meetings were a success, with the panel recognizing PREDICT's work in virology and genomics as "cutting edge" at the Pacifica meeting, and all PREDICT consortium partners coming together on shared plans and goals for the project in New York.

PREDICT worked with the Chinese Academy of Sciences (CAS) to plan and successfully host the "Inaugural Global Virome Project (GVP) Steering Committee and Working Group Meeting", February 6-7, 2017 in Beijing. The GVP seeks to "pre-empt emerging pandemic threats by identifying the majority of unknown viruses throughout the world that are likely to infect humans." This was the first global steering committee meeting since the Bellagio Forum in August. In Beijing, participants, many from PREDICT and EPT-2 partners FAO and WHO worked together to discuss evolving strategies and plans and to establish coordination among working groups. As an instrumental step towards advancing GVP from concept to action, the CAS continued the discussions after the meeting with their own "China National Virome Project" session. For more info on GVP visit: http://www.globalviromeproject.org/

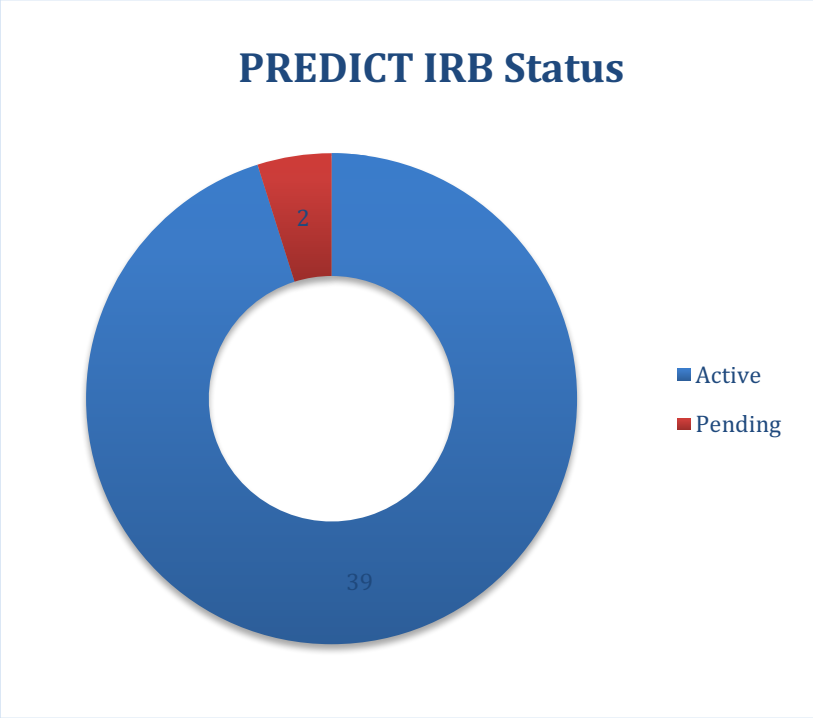
## Personnel

We continued to manage and coordinate an international consortium of partners consisting of over 225 staff, 97% from the host countries or regions where we work.




## Partnerships

Continuing to build and formalize One Health partnerships, we executed 21 subaward agreements since the start of the project, 90% of the agreements with foreign government entities and laboratories in Asia and Africa enabling PREDICT to further advance capabilities for zoonotic disease surveillance, detection, and response.




*Status of permissions from ethical committees (global and host country) approving human subjects research for human surveillance and behavioral risk activities; approvals increased from 70% to over 95% since March 2017.*

## Permissions

PREDICT continued working with global and international partners to ensure compliance with all international and host country laws, regulations, and policies, including Memorandums of Understanding and Letters of Agreement, permissions for conducting research and collecting samples, import and export permissions, biosafety certificates, and ethical clearance for conduct of One Health surveillance (institutional review boards and animal care and use committees).

## Communications

PREDICT continued outreach and communication efforts at the global and host country levels, producing briefings, reports, and online communications and establishing social media channels on Research Gate for scientific publications and presentations and Twitter (@PREDICTproject) for general outreach and information. In addition, PREDICT continued our commitment to open data, making host county government-approved findings available online through the PREDICT BioProject on GenBank and through our HealthMap hosted data portal at www.data.predict.global.

# IV. COUNTRY REPORTS

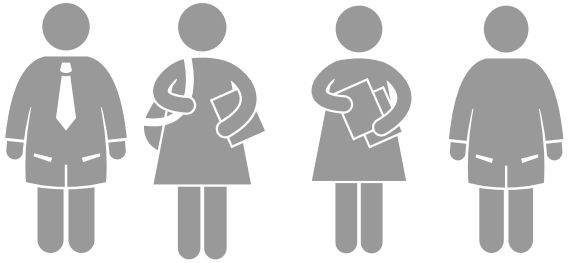
# CAMEROON

USAID | PREDICT
FROM THE AMERICAN PEOPLE

Global Health Security Agenda

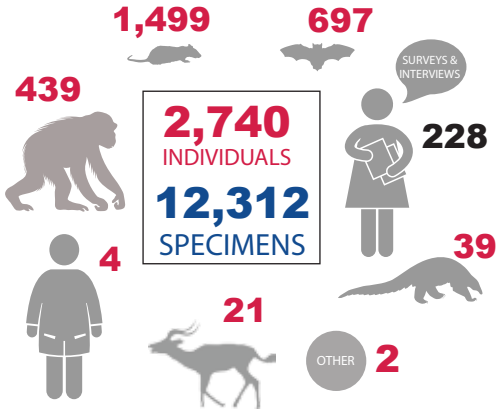
## WORKFORCE DEVELOPMENT

| 34 | 28 | 39 | 73 |
|---|---|---|---|
| STAFF | STUDENTS | GOVERNMENT | OTHER |



103 MALE | 71 FEMALE

## ONE HEALTH SURVEILLANCE




## LAB STRENGTHENING

**25,913** TESTS

CENTRE FOR ARMY HEALTH RESEARCH (CRESAR)

TRAINING → LIMITED TESTING → TESTING ALL TARGET VIRAL FAMILIES

## IMPACT

- **174 trained** in One Health skills
- **2,740 individuals sampled** (wildlife)
- **228 individuals interviewed** in behavioral risk investigations
- **25,913 tests** for 6 viral families
- **118** viruses detected

www.predict.global

## VIRAL FINDINGS

| PREDICT-1 | PREDICT-2 |
|---|---|
| **91** NEW VIRUSES | **6** NEW VIRUSES |
| | **3** PREDICT-1 VIRUSES |
| **15** KNOWN VIRUSES | **3** KNOWN VIRUSES |

# PREDICT/Cameroon

## Success stories

### Enhancing government capacity for outbreak preparedness and response

PREDICT/Cameroon provided outbreak response support to the Government of Cameroon to improve surveillance in an effort to mitigate the spread of monkeypox from neighboring Central Africa Republic, and to rapidly establish etiology in two animal die-off events.

In February 2017, PREDICT provided support to the National Program for the Prevention and Control of Emerging and Re-emerging Zoonotic Diseases to prepare and implement a monkeypox virus awareness and surveillance strengthening workshop. This event used a One Health approach to raise awareness and improve surveillance strategies following recent outbreaks in Cameroon and the Central African Republic. The workshop identified animal species thought to be at risk of contracting monkeypox, and provided training to identify the symptoms, modes of zoonotic transmission, and control and prevention measures. Specifically, PREDICT supported the National Veterinary Laboratory in order to develop proceedures for safe sample collection during monkeypox surveillance.

At the request of the Government of Cameroon, PREDICT also tested samples from two animal die-off events of unknown origin this year: a bat die-off that occurred in May 2017 in Northern Cameroon and a gorilla death in Mambele, Eastern Cameroon in September 2017. Samples were tested for pritority zoonotic diseases and other threats including; corona-, filo-, influenza, and paramyxo-viruses, leading to

*A villager washes clothes near Memvele hydroelectric dam, an area where people and animals share a changing landscape in Cameroon. Photo credit: Dr. Karen Saylors, PREDICT*

detection of one known coronavirus in a straw-colored fruitbat. Results of viral testing for both die-off events were shared with the National Veterinary Laboratory (LANAVET) and the Military Health Research Centre (CRESAR).

### Strengthening workforce capacity and promotion of One Health

PREDICT conducted surveillance for prioritized zoonotic diseases and other emerging disease threats including filoviruses (such as Ebola and Marburg viruses) and influenza

viruses in the South Region of Cameroon (Sangmelima, Meyomessala, and Ebolowa). Bats and rodents living in and around houses and animals in bush meat markets were sampled to identify viruses that could potentially infect people. This surveillance effort was a collaborative partnership between PREDICT and the ministries responsible for livestock (MINEPIA), wildlife (MINFOF), and environment (MINEPDED). Experience gained through hands-on training directly strengthened national capacity of government staff at the central, regional, divisional, and sub-divisional levels for zoonotic disease surveillance. Participants engaged in biosafety; safe animal capture, handling, and sampling; safe sample transport and storage; and viral detection. These multi-partner experiences connected government staff from various ministries, enhancing their skills for improved implementation of a One Health approach to zoonotic disease surveillance and outbreak response. Additionally, PREDICT has continued to provide laboratory learning opportunities for One Health and be a resource for strengthening the roles played by partners in the National Program for Zoonosis such as MINFOF, MINEPIA, and MINEPDED.

### Building capacity in biosecurity, biosafety, and risk management through a One Health approach

Within the framework of One Health Workforce development, in April 2017, PREDICT assisted OHCEA (One Health Central and Eastern Africa) to expand and strengthen the skillsets of 30 health professionals in biosecurity, biosafety, and risk management. Participants were trained in PREDICT protocols for biosafety and use of personal protective equipment (PPE), safe sample collection, as well as handling, storage, and transportation of potentially hazardous and infectious materials. The group was taken into field settings, including public and private hospitals and poultry farms in Douala, to familiarize participants with the use of PPE in different settings. Trainees included regional and divisional delegates of the Ministry of Health and the Ministry of Livestock, Fisheries and Animal Production, Pharmacists from public and private sectors, and representatives from the Universities of Dschang, Buea, Yaoundé, and Montagnes. Training support from PREDICT strengthens collaboration between EPT-2 partners, provides opportunity for professional development in the health workforce and promotes the One Health approach.

## Laboratory systems

PREDICT is partnering with the Military Health Research Center (CRESAR), the project laboratory actively testing all animal samples and assisting with training staff from the National Public Health Laboratory and the National Veterinary Laboratory. CRESAR has capability to perform tests for all five target viral families, which include priority zoonotic diseases such as Ebola, Marburg, and avian influenza.

### Implementing partners

Metabiota, Inc., Global Virome, Mosaic, Military Health Research Center (CRESAR)

### Contacts

**Country Coordinator:** Moctar Mouiche, Metabiota, Inc. (mmouiche@mosaic.com)

**Global Point of Contact**: James Ayukekbong, Metabiota, Inc. (jayukekbong@metabiota.com)

FACES OF
PREDICT

# DR. CAPTAIN FORTUNE EBEN YOUMBA

Captain Fortune Eben Youmba, DVM, joined the PREDICT Cameroon team as an intern after she graduated as a Doctor of Veterinary Medicine in 2015. During her internship, Captain Eben benefited from on-the-job training in PREDICT protocols, including biosafety and safe animal capture, handling, and sample collection through involvement in wildlife surveillance, as well as in PREDICT laboratory protocols at the Military Health Research Center (CRESAR). Captain Eben took part in behavioral risk training during the pilot phase in Cameroon, and was selected to be part of the field team implementing behavioral risk investigations at some of Cameroon's most at-risk animal-human interfaces for zoonotic disease emergence and spread. With this team, she demonstrated strong social science skills and an aptitude for conducting qualitative interviews with a diversity of people. Following her internship with PREDICT, Captain Eben was admitted into the Armed Services Military Academy (EMIA) in Yaoundé for officer training, and upon graduation was assigned to CRESAR by a presidential decree. The head of CRESAR then tasked Captain Eben to work with the PREDICT/ Cameroon team, and through this collaborative relationship, Captain Eben has been building the capacity of the Ministry of Defense for outbreak response and field investigations, fulfilling CRESAR's responsibilities as a member of the military initiative of the African Partner Outbreak Response Alliance (APORA). PREDICT provided invaluable opportunities for Captain Eben to expand her One Health skillset, and her expertise strengthens CRESAR's workforce, a critical node in Cameroon's national system for zoonotic disease prevention, detection, and response and one of the key national laboratories in the fight against emerging infectious diseases. The relationship between PREDICT and CRESAR continues to be an excellent example of civil-military collaboration for early detection of infectious disease threats.

Captain Fortune Eben Youmba, DVM
Photo: PREDICT/Cameroon

Cameroon

Joined PREDICT Cameroon
Entered the Armed Services Military Academy
Assigned to Military Health Research Center
Appointed to PREDICT Cameroon team by presidential decree
2015
2017

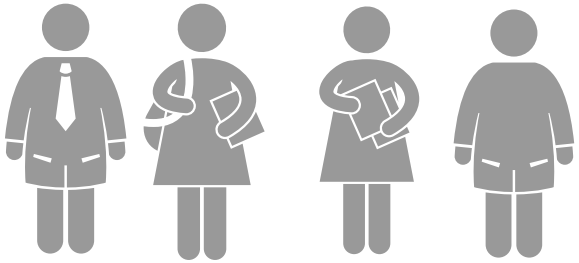
# COTE D'IVOIRE

USAID | PREDICT
FROM THE AMERICAN PEOPLE

Global Health Security Agenda

## WORKFORCE DEVELOPMENT

| 13 | 1 | 1 | 2 |
|---|---|---|---|
| STAFF | STUDENTS | GOVERNMENT | OTHER |



12 MALE | 5 FEMALE

## ONE HEALTH SURVEILLANCE

300

405 INDIVIDUALS
2,430 SPECIMENS

93

12

## LAB STRENGTHENING

TRAINING

4,030 TESTS

INSTITUT PASTEUR DU COTE D'IVOIRE

CENTRAL LABORATORY FOR ANIMAL DISEASES (LANADA)

TRAINING → LIMITED TESTING → TESTING ALL TARGET VIRAL FAMILIES

## IMPACT

**17 trained** in One Health skills

**405 wild animals sampled**

**4,030 tests** for 5 viral families

www.predict.global

A bat captured for sampling by PREDICT in Côte d'Ivoire
*Photo: PREDICT/Côte d'Ivoir*

# PREDICT/Côte d'Ivoire

## Success stories

### Targeting high-risk interfaces

In Côte d'Ivoire, PREDICT is putting the One Health approach into action, working with our in-country partners, Institut Pasteur Côte d'Ivoire (IPCI), and the Laboratoire National d'Appui Développement Agricole (LANADA). In November 2016, the team used their earlier joint training on the practical implementation of a collaborative One Health approach, and conducted field trips to three sites. Through community engagement, PREDICT assessed locations for targeted risk-based concurrent human and wildlife zoonotic disease surveillance. In addition, PREDICT launched wildlife sampling activities, collecting specimens from bats and rodents in the Taï Forest near the border with Liberia. The PREDICT lab team at LANADA also began laboratory screening of samples for priority zoonotic diseases such as Viral Hemorrhagic Fevers, Avian Influenza, and SARS and MERS Coronaviruses along with other emerging threats.

### Official launch of human surveillance in Côte d'Ivoire

On July 13, 2017, the official opening ceremony of PREDICT activities took place in Bonon, Bouaflé Prefecture, a selected risk-interface where project One Health surveillance is being implemented. The ceremony hosted administrative officials representing ministries of agriculture and health, as well as IPCI, LANADA, and local security chiefs. The village chief, USAID/Côte d'Ivoire, and PREDICT gave speeches of support and commitment.

*Community engagement in Sergentkonankro. Photo credit: PREDICT/ Côte d'Ivoire.*

After training and the official opening of the human component of PREDICT, the PREDICT team organized focus groups, conducted ethnographic interviews, administered questionnaires, and collected specimens from patients at the Bonon clinic. In order to explore potential transmission routes between populations, wildlife (bats and rodents) were captured and sampled in Marahoué National Park, close to the clinic selected for syndromic human surveillance. Viral testing for priority zoonotic diseases and other emerging threats is ongoing.

As a result, the Ministry of Waters and Forest requested that government veterinarians receive on-the-job training in animal capture and sampling from PREDICT staff, further adding to capacity-building and strengthening the One Health workforce in the region. While the initial trainings helped build

*Local dignitaries, Côte d'Ivoire authority leaders, USAID/Côte d'Ivoire and PREDICT partnership representatives launch the first human surveillance*

*site in Bonon, Bouaflé Prefecture. Photo credit: PREDICT/ Côte d'Ivoire.*

bridges between national animal and human health sectors, the project's ongoing practical collaboration between IPCI and LANADA is helping solidify the foundation of the One Health approach in the country.
In addition, the team successfully collected and deposited field data into the project information management system, encouraging data sharing across partners for informed decision making, and facilitating a One Health communication and data sharing process.

## Laboratory systems

PREDICT/Côte d'Ivoire is partnering with the Central Laboratory for Animal Diseases, Bingerville (LANADA) and L'Institut Pasteur du Cote d'Ivoire (IPCI) for specimen testing, both are preparing for implementation of viral family protocols for five priority families (corona, filo, flavi, influenza, and paramyxo viruses).

### Implementing partners

EcoHealth Alliance, Institut Pasteur de Côte d'Ivoire (IPCI), Laboratoire d'Appui au Développement Agricole (LANADA), Metabiota Inc.

### Contacts

**Country Coordinator:** Dr. Kalpy Julien Coulibaly (kalpyjuliencoulibaly@pasteur.ci)

**Global Point of Contact:** Peter Daszak (daszak@ecohealthalliance.org)

# DEMOCRATIC REPUBLIC OF CONGO

USAID | PREDICT
FROM THE AMERICAN PEOPLE

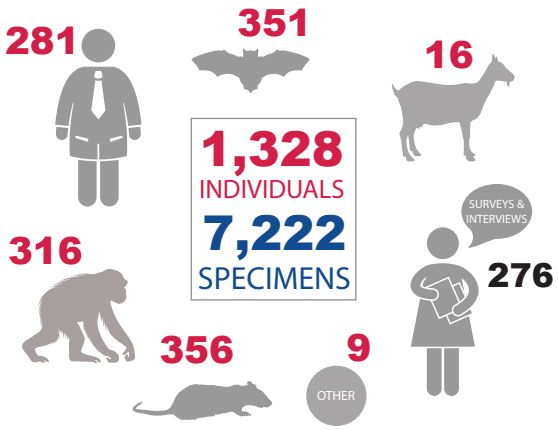
Global Health Security Agenda

## WORKFORCE DEVELOPMENT

| 19 | 5 | 67 | 8 |
|---|---|---|---|
| STAFF | STUDENTS | GOVERNMENT | OTHER |

58 MALE | 41 FEMALE

## ONE HEALTH SURVEILLANCE




## LAB STRENGTHENING

**10,874** TESTS

INSTITUT NATIONAL RECHERCHE BIOMEDICALE

TRAINING → LIMITED TESTING → TESTING ALL TARGET VIRAL FAMILIES

## IMPACT

- **99 trained** in One Health skills
- **1,328 individuals sampled** (humans and animals)
- **276 individuals interviewed** in behavioral risk investigations
- **10,874 tests** for 8 viral families
- **73 viruses** detected

www.predict.global

## VIRAL FINDINGS

| PREDICT-1 | PREDICT-2 |
|---|---|
| **47** NEW VIRUSES | **4** KNOWN VIRUSES |
| **22** KNOWN VIRUSES | |

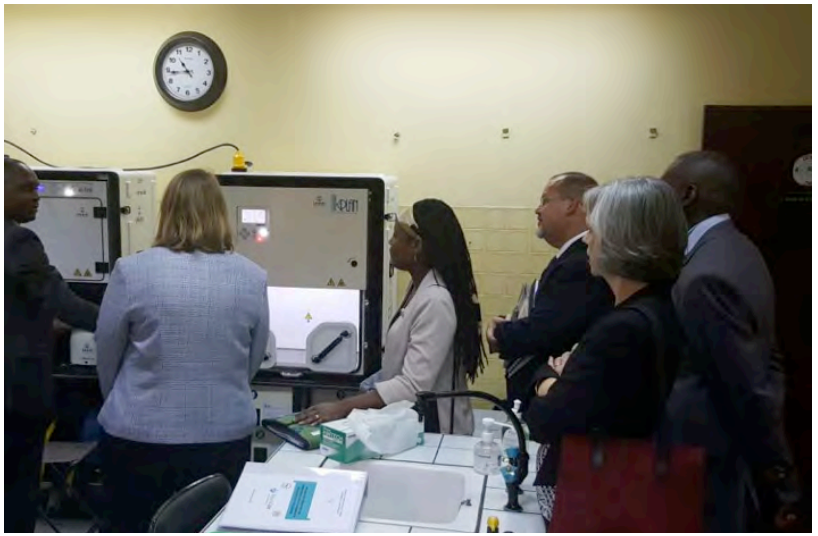
# PREDICT/Democratic Republic of Congo

## Success stories

### Ebolavirus outbreak response support

PREDICT assisted in the early detection of an outbreak of Ebolavirus, a regionally recognized priority zoonotic disease, in the Nambwa health area, Likati health zone, Bas-Uele province in May 2017. After the provincial health office informed the Ministry of Health of three suspected cases (two deaths), five samples collected from patients admitted at the Nambwa Health Center and known to have been in contact with the three suspected cases were sent to the PREDICT partner lab at the Institut National Recherche Biomédicale (INRB). Two samples tested positive for Ebola Zaire virus using real-time PCR. To confirm these results, the Director of INRB requested re-analysis by the PREDICT lab team, using our viral family detection protocols. One sample was confirmed to be positive for filovirus. PREDICT staff prepared and sent the purified product to a commercial laboratory for sequencing, confirming that the outbreak was caused by a strain of Ebolavirus close to the Yambuku (1976) and Boende (2014) viruses.

Supported by the laboratory confirmation of results from the INRB and PREDICT lab teams, the Government of DRC rapidly enacted disease control measures, such as quarantine, contact tracing, and dispatch of the USAID-purchased mobile laboratory and laboratory equipment to the affected region, a resonse effort that greatly increased the likelihood of successful containment procedures for this deadly regional and global health threat.



*The mobile K-Plan laboratory purchased by USAID builds laboratory capacity and outbreak response capabilities and was used during Yellow Fever and Ebola outbreaks in DRC this year. Photo credit: PREDICT/DRC*

### Deploying and sustaining outbreak response activities for Yellow Fever

In support of government-led response efforts during the Yellow Fever outbreak, PREDICT/Democratic Republic of Congo (DRC) facilitated the purchase of a mobile laboratory for use by the DRC national reference laboratory, the INRB. The mobile laboratory strengthened the country's ability to respond to epidemics in remote locations, facilitating the rapid detection of causative agents through serology and molecular biology diagnostic techniques. In order to operationalize the mobile laboratory, PREDICT also provided training for 23 medical biologists and laboratory technicians at the INRB in laboratory biosecurity and safe use of equipment/protocols for virus detection.

In addition, PREDICT-built capacity for zoonotic disease surveillance at INRB was called upon to support Yellow Fever outbreak detection and response activities. PREDICT laboratory facilities and capabilities for virus detection were used for detection of Yellow Fever. PREDICT staff attended 13 investigative trips to Kongo-Central, Kwango, and Kwilu provinces with the Ministry of Health, and provided supplies to maintain cold chain transportation of vaccines during mass immunization campaigns. Although the end of the yellow fever epidemic was officially declared by the Minister of Public Health on February 14, 2017, surveillance efforts continued through March 2017 with samples collected from about one hundred suspected cases per month for analysis at the INRB virology laboratory.

## Collaborative training and support for workforce development

In the spirit of the One Health approach, PREDICT contributed to the Field Epidemiology and Laboratory Training Program (FELTP), launched in partnership between the World Health Organization, the United States Centers for Disease Control and Prevention, the University of Kinshasa, the African Field Epidemiology Network, and USAID. In March 2017, PREDICT provided a learning laboratory for 30 students (medical doctors, veterinarians, medical biologists and laboratory technicians). The cohort of students learned and applied PREDICT protocols, including safe sample collection, animal capture methods, and sample transport and storage and received laboratory-based training in viral detection using conventional PCR analysis and cloning. PREDICT's hands-on support of this residency-based program in applied epidemiology and public health management is helping strengthen workforce capacity for improved capabilities in

*Dr. Charles Kumakamba, PREDICT/DRC Laboratory Manager, explains the conventional PCR process to students from the Field Epidemiology and Laboratory Training Program at Institut National de Recherche Biomédicale (INRB). Photo credit: PREDICT/DRC*

prevention, detection, and response for zoonotic diseases and emerging threats. The training is contributing to improved awareness and operationalization of DRC's One Health platform.

Expanding regional relationships and creating a connected One Health network capable of cross-boundary outbreak response, two PREDICT staff from the Republic of Congo travelled to DRC to expand and strengthen their behavioral risk field investigation skillsets. Members of PREDICT/DRC led practical sessions on the ethical conduct of ethnographic interviews and focus group discussions, as well as post-interview transcribing and analysis of interviews. This training

increased regional capacity for human behavioral research and analysis of qualitative data to better understand behaviors and social factors that put people at risk of zoonotic infection.

## Laboratory systems

PREDICT/DRC is partnering with the Institut National Recherche Biomédicale (INRB) a national lab implementing viral family protocols for five priority families (corona, filo, flavi, influenza, and paramyxo viruses); INRB has also provided testing support for the Republic of Congo.

### Implementing partners

Metabiota, Inc., UC Davis, Institut National de Recherche Biomedicale (INRB), Kinshasa School of Public Health (KSPH), Mountain Gorilla Veterinary Project (MGVP)

### Contacts

**Country Coordinators:** Prime Mulembakani, Metabiota, Inc. (pmulembakani@metabiota.com); Eddy Kambale, MGVP (ekambale@gorilladoctors.org)

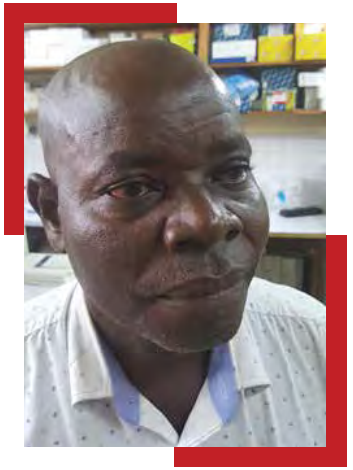
**Global Point of Contact**: James Ayukekbong, Metabiota, Inc. (jayukekbong@metabiota.com)

FACES OF
# PREDICT

# GUY MIDINGI SEPOLO

Mr. Guy Midingi Sepolo, an animal care technician at INRB, joined the PREDICT team in 2011. He has completed extensive trainings in PREDICT protocols and has been mentored by PREDICT staff in biosafety, field trip preparation, safe capture and sampling of wildlife, sample processing and shipment from field to laboratory, cold chain management, data management, as well as advanced training in necropsies, and promotion of safe hunting practices for zoonoses prevention. Building on his experience in animal care at the Kinshasa Zoo and nearly three decades in charge of laboratory animal care at INRB, Midingi's skillset has been greatly expanded and strengthened through participation in PREDICT activities over the past six years. In addition to being an asset to the PREDICT field team for zoonotic disease surveillance, he is also now a member of INRB's outbreak response field investigation team. In May 2017, Midingi was sent to Likati near the epicenter of the Ebola outbreak, where he was tasked with capturing and sampling bats and primates. PREDICT has afforded Guy Midingi Sepolo invaluable opportunities to advance his One Health skillset and increase his knowledge of zoonotic infection and preventive measures, and in turn his capacity and knowledge of safe zoonotic disease surveillance serves INRB and DRC and will be a lasting contribution to DR Congo's One Health workforce.

**The Democratic Republic of Congo**



Guy Midingi Sepolo. Photo: PREDICT DRC

**2011**

- Joined Predict DRC Team
- Continued work with PREDICT-2
- Joined INRB field investigation team for outbreak responses
- Captured and sampled mammals at Likati

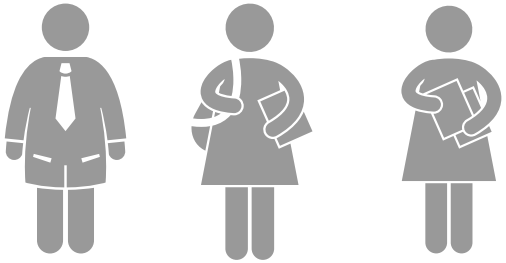
**2017**

# EGYPT

USAID | PREDICT
FROM THE AMERICAN PEOPLE

## WORKFORCE DEVELOPMENT

| 13 | 9 | 18* |
|---|---|---|
| STAFF | STUDENTS | GOVERNMENT |

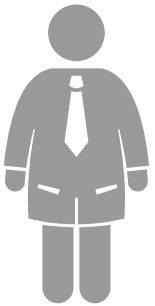


9 MALE | 9 FEMALE

* Trained staff are government employees

## ONE HEALTH SURVEILLANCE

700



601

**1,301** INDIVIDUALS
**3,596** SPECIMENS

## LAB STRENGTHENING

**3,306** TESTS

CENTER OF SCIENTIFIC EXCELLENCE FOR INFLUENZA VIRUSES

TRAINING → LIMITED TESTING → TESTING ALL TARGET VIRAL FAMILIES

## IMPACT

**18 trained** in One Health skills

**1,301 individuals sampled** (humans and animals)

**3,306 tests** for 3 viral families

www.predict.global

A member of the PREDICT/Egypt team records answers for the behavioral risk questionnaire at a camel market. *Photo: A*

## PREDICT/Egypt

# Success stories

### Targeted risk-based surveillance for priority zoonotic diseases

Targeting human and animal populations in the Middle East Respiratory Syndrome Coronavirus (MERS-CoV) epizone, PREDICT/Egypt has initiated One Health surveillance activities targeting high-risk animals (wildlife and livestock) and humans at key interfaces selected in collaboration with Egyptian Government partners and the Food and Agriculture Organization of the United Nations (FAO). To date, the PREDICT team has captured, sampled, and released more than 600 bats. All bat specimens are being tested for corona, filo, paramyxo, and influenza viruses. Additionally, 700 humans have been enrolled in surveillance activities to date, with all participants completing the behavioral risk questionnaire and providing biological specimens for viral testing (which will include serological testing for MERS-CoV antibodies).

### Regional collaboration for One Health surveillance

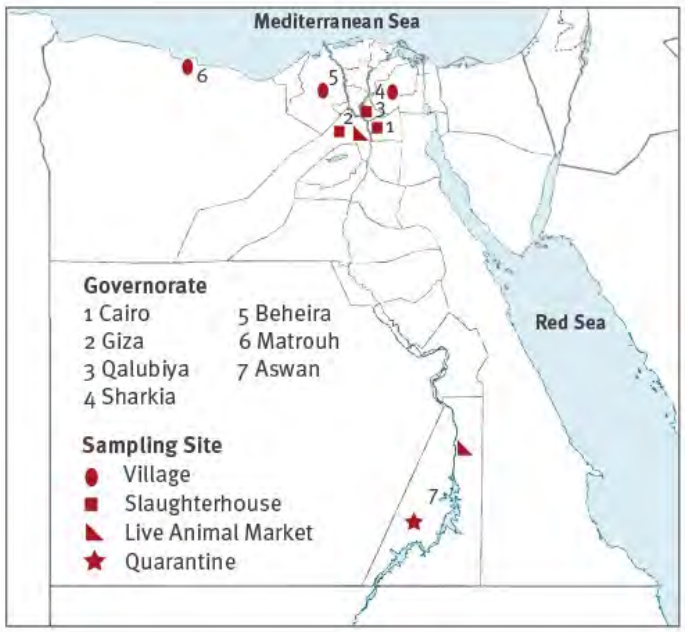
As result of the Egypt team's success in launching and conducting human surveillance activities, as well as the similarities between surveillance objectives in Egypt and Jordan, PREDICT/Egypt provided training to the PREDICT/Jordan team in the project's human surveillance protocols. In July. two members of PREDICT/Egypt traveled to Jordan for one week to conduct classroom and field trainings in coordination with PREDICT global team members. This instance of cross-training supports PREDICT's efforts to

*Ms. Amira Sayed of the PREDICT/Egypt team leads a classroom training on PREDICT community surveillance in Arabic for the PREDICT/Jordan team. Photo by P. Dawson/EcoHealth Alliance.*

encourage regional capacity strengthening and build active One Health networks amongst professionals.

### One Health partnerships lead to new publication on MERS-CoV prevalence

PREDICT supported FAO partners in cross-sectional surveillance activities of camels and bats for MERS-CoV, which resulted in a publication in the journal *Eurosurveillance*. The article entitled "Cross-sectional surveillance of Middle East respiratory syndrome coronavirus (MERS-CoV) in dromedary camels and other mammals in Egypt, August 2015 to January 2016" sheds light on the seroprevalence of MERS-CoV in both imported and resident camel populations in Egypt. While all samples from domestic camels and bats tested negative for MERS-CoV antibodies, one sample from a sheep apparently in contact with seropositive camels was a positive reactor, suggesting cross species transmission may have occurred and warranting further investigation. The article is freely available from *Eurosurveillance* at: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5356426/




*Map of sampling locations for cross-sectional surveillance activities described in the article "Cross-sectional surveillance of Middle East respiratory syndrome coronavirus (MERS-CoV) in dromedary camels and other mammals in Egypt, August 2015 to January 2016". Source: Euro Surveill 2017 Mar 16; 22(11): 30487.*
doi: 10.2807/1560-7917.ES.2017.22.11.30487

## Laboratory systems

PREDICT/Egypt is partnering with the Center of Scientific Excellence for Influenza Viruses (CSEIV) of the Egypt National Research Centre (NRC) for animal and human specimen testing. The lab is currently testing samples from for corona, filo and paramyxo viruses. Human samples are also undergoing serological testing for MERS-CoV antibodies.

## Implementing partners

EcoHealth Alliance and the Egypt National Research Centre (NRC)

## Contacts

**Country Coordinator:** Dr. Mohamed Ahmed Ali, Egypt National Research Centre (mohamedahmedali2004@yahoo.com)

**Global Point of Contact**: Dr. William Karesh, EHA (karesh@ecohealthalliance.org)

**Country Liaison:** Patrick Dawson, EHA (dawson@ecohealthalliance.org)

# ETHIOPIA

USAID | PREDICT
FROM THE AMERICAN PEOPLE

Global Health Security Agenda

## WORKFORCE DEVELOPMENT

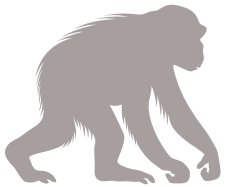
| 3 | 2 | 3 |
|---|---|---|
| STAFF | STUDENTS | OTHER |

7 MALE | 1 FEMALE

## ONE HEALTH SURVEILLANCE

202

235



**437** INDIVIDUALS
**1,232** SPECIMENS

## LAB STRENGTHENING

**114** TESTS

ADDIS ABABA UNIVERSITY AKLILU LEMMA INSTITUTE OF PATHOBIOLOGY

TRAINING → LIMITED TESTING → TESTING ALL TARGET VIRAL FAMILIES

## IMPACT

**8 trained** in One Health skills

**437 individuals sampled** (wildlife)

**114 tests** for 5 viral families

www.predict.global

A vervet monkey chews on an oral swab that will be tested for viruses by the PREDICT/Ethiopia team.
*Photo: PREDICT/Ethiopia*

# PREDICT/Ethiopia

## Success stories

### Supporting the development of a National One Health Council and the Global Health Security Agenda

PREDICT collaborated with partners from USAID/Preparedness and Response, and the Food and Agriculture Organization (FAO) of the United Nations, in technical working groups focused on strengthening capacity for surveillance of priority endemic and emerging zoonotic diseases in Ethiopia. The meetings furthered the progress for developing the Ethiopian One Health National Council with national stakeholders along with special working groups for Anthrax, Rabies, and Brucellosis. PREDICT supports these national One Health initiatives by providing technical assistance for developing and strengthening national capacity, especially through opportunities that put One Health in action through zoonotic disease surveillance at high-risk human-animal interfaces.

### Building up zoonotic disease surveillance capabilities for the wildlife sector in Ethiopia

PREDICT continues to work in partnership with local authorities and the Ethiopian Wildlife Conservation Authority (EWCA) to strengthen capacity for surveillance of wildlife populations for zoonotic disease threats. Over the last year, PREDICT conducted wildlife sampling in communities surrounding the Awash National Park, targeting priority high-risk animal-human interfaces where zoonotic viruses may be shared with livestock and people. The team collected non-invasive samples (saliva and feces) from non-human primates

*A woman and her child wash with an audience of babboons at a priority high risk animal-human interface site near Awash National Park where PREDICT/Ethiopia is collecting wildlife samples. Photo credit: PREDICT/Ethiopia*

(olive baboons, sacred baboons, and grivet monkeys) and bats for zoonotic disease testing. Through continued mentorship and training of the workforce, these activities are enhancing disease detection capacity of the animal health sector.

PREDICT also conducted wildlife sampling activities along the livestock value chain at another high-risk interface in the Bati area of central Ethiopia. At this site, the team successfully collected bat and non-human primates for transfer to and

screening at the Addis Ababa University PREDICT laboratory for priority zoonotic diseases and other emerging threats. By working together with EWCA, PREDICT is directly supporting improvements in wildlife disease surveillance and helping to address a critical gap in the national plan targeting improvements in the animal health sector for zoonotic disease detection and response.

### Strengthening regional networks, building laboratory capacity and improving the workforce for disease detection

For detection of priority zoonotic diseases, a well-trained and equipped workforce with established connections between a strong regional network of trained professionals is crucial. The PREDICT network includes representatives from the National Animal Health Diagnostic and Investigation Center (NAHDIC), EWCA, FAO-ECTAD, EPHI, and CDC Ethiopia.

PREDICT facilitated several training sessions over the last year. In October 2016, PREDICT staff traveled to Uganda to receive training and mentorship from project partners at the Makerere University. In addition, in February 2017, one of PREDICT's global subject matter experts from University of California, Davis led workshops at Addis Ababa University for seven participants including project staff, students, and government partners from the Ethiopia Public Health Institute and National Animal Health Disease Investigation Centre. These workshops introduced and reinforced standard operating procedures and practices for laboratory work, including basic laboratory safety, emergency preparedness, safe waste disposal, and hands-on training in nucleic acid extraction and viral detection techniques. As a result of the trainings, the PREDICT team and a network of government laboratory personnel gained core skills and capacity for viral detection, thus developing technical lab capabilities in support of a national One Health platform.

## Laboratory systems

PREDICT is partnering with the new laboratory at the Aklilu Lemma Institute of Pathobiology in the Sefere Selam area of Addis Ababa. The laboratory provides improved infrastructure to conduct testing of wildlife samples for priority zoonotic diseases and other emerging threats for five viral families. Additionally, an agreement between EPHI and AAU has been established to use laboratory space at both institutes as needed for human syndromic surveillance sample testing.

### Implementing partners

UC Davis; Addis Ababa University, Aklilu Lemma Institute of Pathobiology; and the Ethiopian Public Health Institute

### Contacts

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**Global Point of Contact**: Professor Woutrina Smith, UC Davis (wasmith@ucdavis.edu)

# GHANA

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Global Health Security Agenda

## WORKFORCE DEVELOPMENT

**9** STAFF

**8** GOVERNMENT

10 MALE | 5 FEMALE

## ONE HEALTH SURVEILLANCE

**994**

**179**

**1,335** INDIVIDUALS

**4,698** SPECIMENS

**162**

## LAB STRENGTHENING

TRAINING

TRAINING

ACCRA VETERINARY LABORATORY

NOGUCHI MEMORIAL INSTITUTE FOR MEDICAL RESEARCH

TRAINING → LIMITED TESTING → TESTING ALL TARGET VIRAL FAMILIES

## IMPACT

**15 trained** in One Health skills

**1,335 individuals sampled** (wildlife)

**Training initiated** for viral testing

www.predict.global

Mona monkeys (*Cercopithecus mona*) and sheep feed on discarded corn cobs/husks immediately adjacent to a home in a village near the Boabeng-Fiema Monkey Sanctuary.
*Photo: Terra Kelly*

# PREDICT/Ghana

## Success stories

### Putting One Health in practice: operationalizing Ghana's national One Health platform

PREDICT/Ghana's One Health team is comprised of members from Ghana's national animal and human health systems, all working together to put One Heath in practice through the project's zoonotic disease surveillance activities. With members from the Wildlife Division of the Forestry Commission, Ministry of Land and Natural Resources; Veterinary Services Directorate, Ministry of Food and Agriculture, Noguchi Memorial Institute for Medical Research at the University of Ghana; Ghana Health Services; and Public Health Division of the Ghana Armed Forces, PREDICT is directly encouraging interministerial collaboration and providing the opportunity for these partners to work together in field and lab settings, directly strengthening cross sectoral information and data sharing and helping enhance capabilities for early zoonotic disease prevention, detection, and response.

### Developing the implementation plan for GHSA Zoonoses Action Package

PREDICT/Ghana has been involved in the Joint External Evaluation of IHR Core Capacities of Ghana. A JEE evaluation was conducted with external subject matter experts from WHO, CDC, the Norwegian Institute of Public Health, the German Development cooperation (GIZ), the Japanese Development Cooperation (JICA), and the FAO, facilitating the validation of the self-assessment report and scores previously reported by multi-sectoral and multidisciplinary stakeholders in Ghana. In June and October, PREDICT was invited to assist

*A Mona monkey raiding food in Boabeng village where PREDICT is investigating the risk of spillover of viruses from monkeys vising the local communities. Photo credit: PREDICT/Ghana*

the Ghana Health Service and key national and international stakeholders to develop the national implementation plan. PREDICT led development of the Zoonoses Action Package with PREDICT's Wildlife Disease Coordinator from the Wildlife Division of the Forestry Commission serving as the chair and PREDICT/Ghana's Country Coordinator a member of the team. In addition, PREDICT/Ghana's Human Disease Surveillance Coordinator from Noguchi Memorial Institute of Medical Research, University of Ghana chaired the team that developed the plan for the Biosafety and Biosecurity Action Package with participation by PREDICT's partner in the Ghana Armed Forces, Commander Nyarko.

## Strengthening surveillance networks for emerging infectious diseases in Ghana

PREDICT/Ghana has developed partnerships with and between local and national organizations applying the One Health approach to counter diseases of pandemic potential. Fostering international relationships, PREDICT representatives within the Wildlife Division of the Ghanaian Government hosted the United States Ambassador to Ghana on a tour of PREDICT field surveillance activities. The Ambassador had the opportunity to visit one of PREDICT's priority zoonotic surveillance sites, and observed non-invasive collection of saliva from Mona monkeys which closely interact with the community and have been observed foraging for food, freely entering peoples' homes, and feeding alongside livestock in the fields.

Prior to launch of human disease surveillance activities, a member of the PREDICT team at Noguchi Memorial Institute for Medical Research traveled to Uganda to participate in a five-day human disease surveillance sampling event and receive training on PREDICT human disease surveillance protocols, part of the PREDICT project's approach to building inter-regional relationships and One Health networks.

PREDICT conducted visits to the Brong Ahafo and Greater Accra regions in Ghana to meet with the regional Ghana Health Service authorities, Public Health Division of the Ghana Armed Forces, and selected health facilities identified to be key sites for PREDICT's human syndromic surveillance activities. The participants discussed priorities and planning for implementation of PREDICT's human disease surveillance activities in these regions. These close partnerships between the Ghana Health Service, Ghana Armed Forces, and Noguchi Memorial Institute for Medical Research provide a strong

*Dr. Samuel Bel-Nono, PREDICT/Ghana Country Coordinator and Dr. Meyir Zieka, Wildlife Division met with the United States Ambassador to Ghana, Robert Jackson, during his visit to PREDICT's surveillance site near the villages of Boabeng and Fiema. Photo credit: PREDICT/Ghana.*

foundation for integrating surveillance for emerging zoonoses into the national disease surveillance system and incorporating data collection needed to better understand which behaviors may increase risk of transmission of zoonotic viruses from animal to human populations.

The PREDICT/Ghana team is conducting concurrent human and wildlife disease surveillance at two sites in Ghana. At Boabeng-Fiema, PREDICT is sampling bats, rodents, and non-human primates that interact closely with the community. At the 37 Military Hospital site in Accra, which has a colony of an estimated 1 million straw colored fruit bats, PREDICT is sampling bats and rodents. As part of this surveillance,

PREDICT is conducting monthly bat population censuses and non-invasive sampling in order to understand the dynamics of coronavirus shedding in the bats living in this very busy urban center.

### Enhancing analytical skills to assess risk of emergence of zoonotic disease in Ghana

Dr. Richard Suu-Ire from the Wildlife Division, Forestry Commission in Ghana received the PREDICT Modeling and Analytics Fellowship sponsored by EcoHealth Alliance in New York City, USA. Dr. Suu-Ire participated in the program from July 5th – August 5th, 2017 and received training on the use of ecological niche modelling to generate predictive risk maps of pathogen emergence. The fellowship provided Dr. Suu-Ire with critical skills needed to lead an assessment of the spatial distribution of risk for Henipavirus emergence in Ghana. Dr. Suu-Ire is conducting the analyses and will be the lead author on a manuscript stemming from this work.

### Improving community awareness of One Health

PREDICT assisted with the coordination of a community awareness forum to celebrate World Rabies Day on September 28, 2017. The event was held in Suhum, a town in the Eastern Region of Ghana that is a hotspot for rabies. The event was sponsored by Rabies in West Africa (RIWA) in conjunction with the Ghana Veterinary Services Directorate, the Suhum Municipal Assembly, and World Animal Protection. At the forum, PREDICT team members assisted with outreach activities to enhance capacity among health personnel including veterinarians, health workers, NGOs/IGOs, social workers in rabies management, and to educate farmers and pet owners in the community on the threat of rabies to human and animal health, preventive measures, and the One Health approach that the government of Ghana is using to tackle the disease.

## Laboratory systems

PREDICT/Ghana is partnering with the Accra Veterinary Laboratory, Veterinary Services Directorate, Ministry of Food and Agriculture for animal sample testing, and the Noguchi Memorial Institute for Medical Research at the University of Ghana for human sample testing. Both labs are preparing to implement testing for priority zoonotic diseases and other emerging threats and screening samples for five viral families: corona, filo, flavi, influenza, and paramyxoviruses.

### Implementing partners

UC Davis; Wildlife Division of the Forestry Commission, Ministry of Land and Natural Resources; Veterinary Services Directorate, Ministry of Food and Agriculture, Noguchi Memorial Institute for Medical Research at the University of Ghana; Ghana Health Services; and Public Health Division of the Ghana Armed Forces

### Contacts

**Country Coordinator:** Samuel Bel-Nono, Noguchi Memorial Institute for Medical Research (belsam1044@gmail.com)

**Global Points of Contact**: Terra Kelly, UC Davis (trkelly@ucdavis.edu)

# GUINEA

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Global Health Security Agenda

## WORKFORCE DEVELOPMENT

**37** STAFF

**9** OTHER

40 MALE | 6 FEMALE

## ONE HEALTH SURVEILLANCE

**321**

**757**

**1,280** INDIVIDUALS

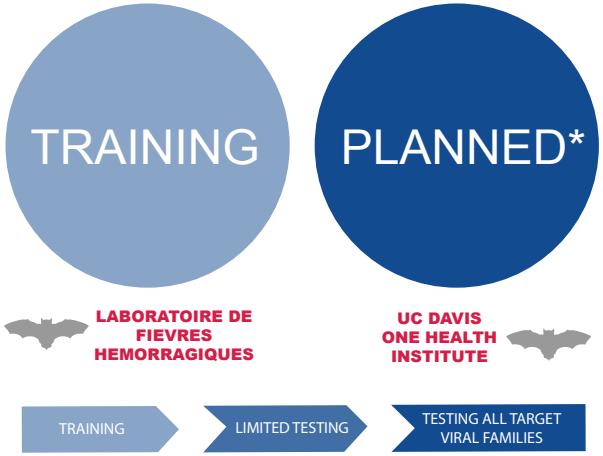
**7,256** SPECIMENS

**8**

**188**

**6**

## LAB STRENGTHENING




*As part of the Ebola Host Project, samples will be tested at UC Davis to accelerate release of viral findings for use for decision-making and risk mitigation efforts.

## IMPACT

**46 trained** in One Health skills

**1,280 individuals sampled** (wildlife and domestic animals)

**Training initiated** for viral testing

www.predict.global

The PREDICT/Guinea team collects samples from a bat as part of the Ebola Host Project.
*Photo: PREDICT/Guinea.*

## PREDICT/Guinea

**Guinea is implementing the Ebola Host Project along with PREDICT teams in Liberia and Sierra Leone.*

## Success stories

### Strengthening One Health surveillance for Ebola virus and other priority zoonotic diseases

PREDICT continues to work in collaboration with local partners from the Ministries of Livestock and Animal Resources; Environment, Water, and Forestry; Research and Higher Education; and Health in lower and Forested Guinea. Surveillance activities were conducted at key human-animal interfaces where people have high levels of contact with animals. Sites in the Forest Region were chosen to cover a range of human-animal interfaces, including urban and rural human settlements within natural, agricultural, and hunting settings. Together with local government partners, PREDICT collected samples from over 1,200 animals including bats, rodents, goat/sheep, pigs, and dogs.

As part of the effort for strengthening surveillance of zoonotic diseases and pathogens in West Africa, team members from Guinea travelled to Sierra Leone and joined the PREDICT/Sierra Leone and Senegal teams in a refresher field training workshop on project protocols for safe animal sampling, cold chain, sample storage and transport, data management, and biosafety and biosecurity.

### Supporting the National One Health Platform

PREDICT collaborated with partners from the Food and Agricultural Organization (FAO) and USAID/Preparedness and

*The PREDICT/Guinea team processes bat samples as part of Ebola Host Project sampling activities. Photo: PREDICT/ Guinea*

Response (P&R) in technical working groups focused on strengthening capacity for surveillance of priority endemic and emerging zoonotic diseases in Guinea. As a member of the Coordination Committee of Guinea's One Health Platform, PREDICT participates in regular meetings with national stakeholders targeting the strengthening of capacity to respond to priority zoonotic diseases. Through these platforms PREDICT continues to foster discussions and collaborations on multi-sectoral zoonosis detection and response, providing technical input when necessary and promoting the One Health approach through action.

### Building partnerships and developing the health workforce

Directly contributing to improvements in national workforce capacity and zoonotic disease surveillance and detection capability, PREDICT established a partnership with the Guinea Viral Hemorrhagic Fever Laboratory at the Gamal Abdel Nasser University of Conakry (VHF Lab). To date, a total of 25

individuals have been trained in up to 20 PREDICT protocols, including biosafety and biosecurity, safe wildlife capture and sampling, sample storage and transport, cold chain, and data management. PREDICT is embedded within the VHF Lab and provides ongoing training, including hands-on opportunities during project field activities for students, interns, and staff to engage in PREDICT activities, thereby directly strengthening Guinea's health workforce and supporting improved capability gains for this critical node in the national disease surveillance and detection system.

## Laboratory strengthening

PREDICT is partnering with Guinea Viral Hemorrhagic Fever Laboratory at the GAMAL Abdel Nasser University of Conakry. As part of the Ebola Host Project, samples are being tested at UC Davis to accelerate release of viral findings for use for decision-making and risk mitigation efforts. The Viral Hemorrhagic Fever laboratory is preparing for training on filovirus family testing, and as a result, the country will have the capacity to detect priority zoonotic diseases, such as the Ebola virus along with other emerging threats.

## Implementing partners

UC Davis, Guinea Viral Hemorrhagic Fever Laboratory

## Contacts

**Country Coordinator:** Alpha Camara, UCD (alphakera@gmail.com)

**Global Point of Contact:** Corina Grigorescu Monagin UCD (cgmonagin@ucdavis.edu)

# JORDAN

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Global Health Security Agenda

## WORKFORCE DEVELOPMENT

**12** STAFF
**2** GOVERNMENT
**2** OTHER

11 MALE | 4 FEMALE

## ONE HEALTH SURVEILLANCE

**566**

**191**

**757** INDIVIDUALS
**5,230** SPECIMENS

## LAB STRENGTHENING

**3,000** TESTS

JORDAN UNIVERSITY OF SCIENCE AND TECHNOLOGY (JUST)

TRAINING → LIMITED TESTING → TESTING ALL TARGET VIRAL FAMILIES

## IMPACT

**16 trained** in One Health skills

**757 individuals sampled** (humans and animals)

**3,000 tests** for 4 viral families

www.predict.global

A camel farm in Ramtha, Jordan, near the Jordanian-Syrian border, where PREDICT/Jordan began interviewing people and collecting samples for human viral surveillance in July 2017. This human-animal interface features numerous animal taxa cohabitating like the camels and chickens pictured above.
*Photo credit: P. Dawson/EcoHealt*

# PREDICT/Jordan

## Success stories

### Collaborative One Health training

PREDICT/Jordan organized a technical coordination workshop entitled, “Advancing Health Security in Jordan - Linking People, Animals and Environment” on February 26, 2017 in Amman in collaboration with USAID/Jordan. The event was attended by senior officials from USAID/Jordan, the World Health Organization (WHO), the Food and Agriculture Organization of the United Nations (FAO), World Organization for Animal Health (OIE), Ministry of Agriculture (MOA), Ministry of Health (MOH), Ministry of Environment (MOE), as well as the Deans of Research, Medicine and Veterinary Medicine, professors, and Master’s students from Jordan University of Science and Technology (JUST). A total of 40 participants attended the workshop and technical sessions. The aim of this workshop was to coordinate efforts by domestic and international stakeholders and partners working in Jordan to apply a One Health framework to health security. At the end of the technical sessions meeting attendees created an overall strategic work plan to advance collaboration and strengthen One Health in Jordan, as well as individual recommendations to stakeholders. Since February, representatives from WHO, USAID, MOA, MOH, and MOE, amongst others, have continued to meet on a quarterly basis, providing a standing platform for One Health information sharing and cooperation.

### Sustaining collaborative partnerships for One Health

Although PREDICT initiated activities in Jordan less than one year ago, all project focal points are now fully engaged, including partners from the MOA, MOH, MOE, WHO, FAO, OIE, and Royal Scientific Society. Additionally, the PREDICT/Jordan country coordinator regularly meets with the project liaison at USAID/Jordan to plan activities, share project updates, facilitate partner coordination, and monitor progress. PREDICT focal points from MOA, MOH, and MOE now meet regularly with PREDICT and USAID/Jordan, and they have forged the beginning of a collaborative platform to formally promote One Health activities in-country. These relationships founded on effective communication will be key in responding to future outbreaks of zoonotic diseases and achieving disease surveillance sustainability in Jordan.

*Participants of the "Advancing Health Security in Jordan - Linking People, Animals and Environment" Meeting in Amman, Jordan. Photo credit: USAID/Jordan.*

## USAID/Jordan support bolsters PREDICT One Health surveillance activities

In April, USAID/Jordan committed an additional $200K USD to support the activities of PREDICT/Jordan, enabling the team to significantly expand the scope planned One Health surveillance activiites. As a result of this Mission buy-in, the team was able to sample twice as many bats as originally planned, and significantly expand the number and type of samples screened for priority viral families. Supplementary Mission funding also enabled the PREDICT team to hire additional team members for human community surveillance and as a result, PREDICT was able to interview and sample nearly 200 individuals within three months of initiating human community surveillance in late July 2017. Going forward, the team will use this additional support to expand the project scope by training veterinarians and laboratory technicians in Southern Jordan, where capacity for viral and field surveillance is limited.

## Laboratory systems

PREDICT/Jordan's laboratories are based at the Jordan University of Science and Technology (JUST). The Diagnostic Lab at the Veterinary Health Center and Molecular Biology Lab is implementing priority viral family testing for human, wildlife, and camel samples. Sequencing is being conducted at JUST's Princess Haya Biotechnology Center.

### Implementing partners

EcoHealth Alliance, Jordan University of Science and Technology (JUST)

*A camel farm in Ramtha, Jordan, near the Jordanian-Syrian border, where PREDICT/Jordan began interviewing people and collecting samples for human viral surveillance in July 2017. This human-animal interface features numerous animal taxa cohabitating like the camels and chickens pictured above. Photo credit: P. Dawson/EcoHealth Alliance.*

### Contacts

**Country Coordinator:** Dr. Ehab Abu-Basha, JUST (abubasha@just.edu.jo)

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**Country Liaison:** Patrick Dawson, EHA (dawson@ecohealthalliance.org)

# KENYA

USAID FROM THE AMERICAN PEOPLE | PREDICT

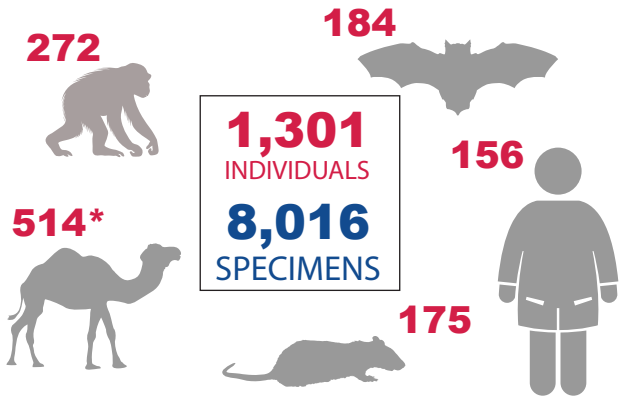
Global Health Security Agenda

## WORKFORCE DEVELOPMENT

| 3 | 7 | 18 | 28 |
|---|---|---|---|
| STAFF | STUDENTS | GOVERNMENT | OTHER |

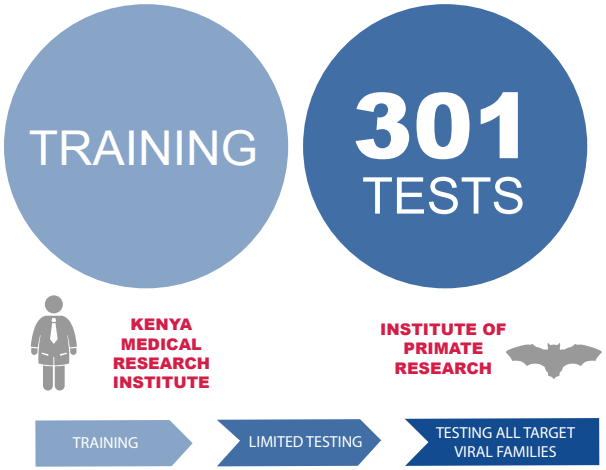
34 MALE | 22 FEMALE

## ONE HEALTH SURVEILLANCE




*Samples collected in collaboration with FAO

## LAB STRENGTHENING




## IMPACT

**301 tests** for coronaviruses

**56 trained** in One Health skills

**1,301 individuals sampled** (humans and animals)

www.predict.global

Children from the Turkana tribe watch PREDICT/Kenya field veterinarian Dr. Daniel Chai obtain samples from rodents in northern Kenya. *Photo: Dawn Zimmerman, PREDICT/Kenya*

## PREDICT/Kenya

## Success stories

### One Health surveillance for nationally recognized priority zoonotic diseases

PREDICT launched concurrent wildlife and livestock surveillance activities in Laikipia and Turkana counties, areas targeted as a high-risk human-animal interface along the animal value chain of dromedary camels. During three seasonal surveillance trips in Laikipia and one in Turkana, PREDICT collected over 5,000 specimens from non-human primates (NHP), bats, rodents, and camels at interfaces where there was a high level of interaction between humans and animals. Camel samples were collected at ranches in Laikipia, and from pastoralist herds in Turkana. Concurrent bat, rodent, and NHP samples were collected from animals in adjacent dwellings, cropland, and natural areas within close proximity to public spaces. Laboratory testing of animal samples has been initiated at the Institute of Primate Research Laboratory using PREDICT protocols to screen for both priority zoonotic viruses of national public health concern, like Ebola, along with other novel and emerging viral threats.

During the September collection in Laikipia, PREDICT commenced human behavioral risk assessments. More than 150 Laikipia residents, many of whom have direct contact with camels or wildlife and may be at risk for zoonotic disease exposure, enrolled in the study and provided specimens for viral testing. Since PREDICT surveillance was implemented in Kenya, over 8,000 (animal and human) specimens have been collected.

*Women of the Turkana tribe. PREDICT/Kenya sampled wildlife and camels present in South Turkana. Photo credit: PREDICT/Kenya.*

### Supporting emergency outbreak preparedness and response

Following notification of an outbreak of avian influenza in neighboring Uganda, PREDICT participated in an avian influenza consultative meeting convened by the Directorate of Veterinary Services (DVS). The meeting on January 18th (two days following the notification of the outbreak) was held to identify actionable steps in avian influenza surveillance, prevention, and control. PREDICT discussed and shared protocols (basic laboratory safety, biosafety and personal protective equipment (PPE) use, cold chain, and avian sampling methods) with the outbreak surveillance team as they prepared to collect samples. PREDICT was requested to standby in case support was required for sample testing.

Through this experience, key personnel gained experience preparing to support outbreak response activities, and as a result, systems and communications in coordination between in-country partners were improved.

### Sustaining One Health collaborative partnerships

PREDICT participated in the Kenya Joint External Evaluation (JEE), the collaborative public health assessment aligned with the Global Health Security Agenda (GHSA). In addition to the primary JEE workshop, PREDICT provided technical assistance on the importance of including high-risk wildlife-human interfaces for viral surveillance in JEE planning with Food and Agriculture Organization of the United Nations (FAO) partners during a meeting focused on aligning FAO's GHSA work plan to the JEE. PREDICT continues to support FAO objectives through workforce development, advanced viral detection of priority zoonotic diseases (if requested), and strengthening national laboratory capacity within the animal and public health laboratory systems.

Additionally, PREDICT participated in a Kenya One Health strategic planning and policy formulation meeting organized by Preparedness and Response (P&R) and the Zoonotic Disease Unit (ZDU). Discussions included how to expand the ZDU to accommodate all key components of One Health, including public health, livestock/agriculture, and wildlife/environment and what policies may be implemented to align Kenyan government ministries to the One Health agenda.

### One Health capacity strengthening

PREDICT, in collaboration with FAO, hosted a two-day zoonotic disease surveillance training workshop that included trainings for biosafety during animal sampling, with a demonstration of safe collection of invasive baboon samples.

Encouraging a cross-disciplinary One Health workforce, over 35 participants from different Government of Kenya sectors and educational institutions attended the workshop, which included representatives from; Central Veterinary Laboratory (CVL), Kenya Wildlife Service (KWS), Kenya Agriculture and Livestock Organization (KALRO), Kenya Medical Research Institute (KEMRI), Directorate of Veterinary Service (DVS), Ministry of Health (MoH – prior to suspension), Zoonotic Disease Unit (ZDU), Institute of Primate Research (IPR), and University of Nairobi.

PREDICT expanded capacity for zoonotic surveillance through practical experience and training of local sub-county veterinarians, KWS veterinarians, interns (Kenyatta University, National Museums of Kenya, IPR, and KEMRI), community-based human and animal health workers, and nurses from Community Health Africa Trust (an NGO that provides health care to remote populations, often travelling by camel to reach villages). Professional development opportunities included in-service training of safe animal capture, biosafety, PPE, animal handling, and sampling of livestock, bats, and rodents, during animal surveillance trips in Turkana and Laikipia counties. Additionally, participants were provided training in ethical and safe human surveillance practices including human ethics protocols, the process of informed consent, and human questionnaire administration.

## Laboratory systems

PREDICT is partnering with the Institute of Primate Research (IPR) and Kenya Medical Research Institute (KEMRI) laboratories for animal and human testing, respectively. The IPR lab has begun testing samples for priority zoonotic diseases and other emerging threats from four viral families (corona-, filo-, paramyxo-, and influenza viruses). The KEMRI lab is preparing to implement viral family testing for human

samples. Additionally, IPR has agreed to host the Central Veterinary Lab (CVL) for a two-week in-service training on PREDICT protocols for priority zoonotic diseases, training that will further enhance zoonotic disease detection capability of Kenya's national laboratory system.

## Implementing partners

Smithsonian Institution, Institute of Primate Research, and Kenya Medical Research Institute

## Contacts

**Country Coordinator:** Dr. Joseph Kamau, IPR (jkamau@primateresearch.org)

**Global Point of Contact**: Dr. Dawn Zimmerman, SI (zimmermand@si.edu)

# LIBERIA

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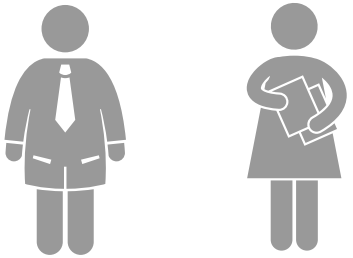
Global Health Security Agenda

## WORKFORCE DEVELOPMENT

**21** STAFF

**5** OTHER



18 MALE | 8 FEMALE

## ONE HEALTH SURVEILLANCE

**2,136**

**2,136** INDIVIDUALS

**11,761** SPECIMENS

## LAB STRENGTHENING

TRAINING — NATIONAL REFERENCE LABORATORY

TRAINING — LIBERIA INSTITUTE FOR BIOMEDICAL RESEARCH

**522*** TESTS — COLUMBIA UNIVERSITY CENTER FOR INFECTION AND IMMUNITY

TRAINING → LIMITED TESTING → TESTING ALL TARGET VIRAL FAMILIES

*As part of the Ebola Host Project, samples are being tested at Columbia University to accelerate release of viral findings for use for decision-making and risk mitigation efforts.

## IMPACT

**26 trained** in One Health skills

**2,136 bats sampled**

**522 tests** run for Ebola and other filoviruses

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The PREDICT/Liberia team processes bat samples in a field tent as part of Ebola Host Project sampling activities. *Photo: PREDICT Liberia.*

## PREDICT/Liberia*

**Liberia is implementing the Ebola Host Project along with PREDICT teams in Guinea and Sierra Leone.*

## Success stories

### Liberia's first zoonotic disease surveillance team

PREDICT successfully trained 15 Liberians to conduct safe wildlife and domestic animal biosurveillance for zoonotic diseases and emerging threats, as well as two social scientists that accompany the animal surveillance team to better understand human behavioral risk as it relates to wildlife exposure. This zoonotic disease surveillance team is the first of its kind in Liberia and is now highly proficient and professional, operating under PREDICT Standard Operating Procedures that include strict Personal Protective Equipment (PPE) and biosafety practices and humane techniques for live animal capture, handling, and sampling. PREDICT has sampled over 2,300 free ranging bats and rodents over the past year, experience that has elevated this team to a level that can contribute to disease response efforts during a crisis, as well as preemptively conduct surveillance in wildlife populations for disease threats before they emerge, both critical but previously absent capabilities in Liberia's national health system.

*The PREDICT/Liberia team is trained on safe rodent sampling techniques in June 2017. Photo credit: Leticia Gutiérrez Jiménez/EcoHealth Alliance.*

### Strengthening national partnerships for One Health

PREDICT continues to promote One Health approaches within the public health sector by strengthening collaborations with the Ministry of Agriculture, FAO, National Public Health Institute of Liberia, and the Ministry of Health. PREDICT participated in weekly National Epidemic Preparedness and Response Committee meetings at the Ministry of Health and provided input and consultation on zoonotic disease issues. In addition, in an example of USAID Emerging Pandemic Threats and One Health partner collaboration, PREDICT assisted Food and Agriculture Organization (FAO) partners in the development of their annual workplan and ensured that it aligned with developing plans for the World Bank Regional Disease Surveillance Strategy Enhancement (REDISSE) in West Africa.

Working to develop One Health communication networks for epidemiological evaluation of test results, PREDICT shared initial test results from wildlife disease surveillance with the Liberia Ministry of Health, Ministry of Agriculture, and the Liberia Forestry Development Authority (all results pending approval for public release).

In addition, PREDICT connected with ministry partners at the Forestry Development Authority (FDA), an institution responsible for wildlife in Liberia, to formalize integration of FDA officers into PREDICT's Ebola Host Project wildlife field sampling activities. This collaboration will institutionalize core capacity for biological sampling for zoonotic surveillance within the Liberia Wildlife Authority. The FDA agreed to identify four officers for training and rotations with the PREDICT team at the Society for Conservation for Nature for Liberia (SCNL) team, while SCNL and FDA continue to establish a working partnership mechanism. To date, PREDICT has trained two personnel from the FDA on field surveillance techniques, the first step in a growing contribution to Liberia's animal health workforce.

### Public-private partnerships for viral surveillance with the extractive industries

Through public-private partnerships, PREDICT is working to break down barriers that could hinder surveillance in critical ecological zones and high-risk human-animal interfaces. For example, PREDICT is working with Arcelor Mittal in Liberia to explore collaborative opportunities that promote improved understanding of viral spillover and spread and mitigate risks for zoonotic disease transmission from extractive industry activities. With Arcelor Mittal, the team assisted with a bat translocation operation on a mining concession, successfully translocating over 1,500 bats from a developing mineshaft to an artificial roosting site. With company and ministry permission, PREDICT screened a portion of the bats for zoonotic viral threats, including Ebola and related viruses, to assist Arcelor Mittal and the Government of Liberia in understanding the potential health risks associated with re-location efforts. All tests are pending interpretation and approval for public release.

## Laboratory systems

PREDICT/Liberia is exploring partnerships with the National Reference Laboratory (NRL) and Liberia Institute for Biomedical Research (LIBR) to assess potential plans for strengthening national laboratory capacity. As part of the Ebola Host Project, wildlife samples are being tested at Columbia University, one of PREDICT's global reference labs, to accelerate release of viral findings for use for decision-making and risk mitigation efforts.

### Implementing partners

EcoHealth Alliance (EHA) and the Society for the Conservation of Nature, Liberia (SCNL)

### Contacts

**Country Coordinator:** Dr. James Desmond, EHA (desmond@ecohealthalliance.org)

**Global Point of Contact**: Dr. Jon Epstein, EHA (epstein@ecohealthalliance.org)

# REPUBLIC OF CONGO

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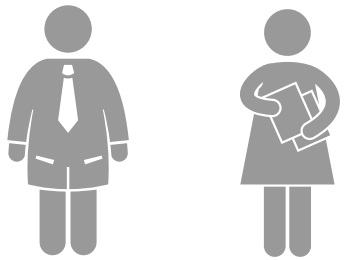
## WORKFORCE DEVELOPMENT

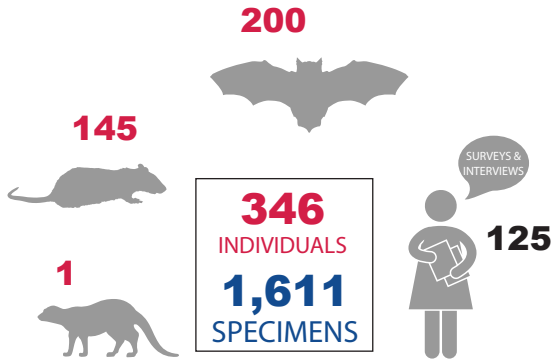
**7** STAFF

**5** GOVERNMENT



8 MALE | 2 FEMALE

## ONE HEALTH SURVEILLANCE




## LAB STRENGTHENING

**4,461*** TESTS

INSTITUT NATIONAL RECHERCHE BIOMEDICALE (INRB)

TRAINING → LIMITED TESTING → TESTING ALL TARGET VIRAL FAMILIES

*To date, animal specimen testing has been conducted by partners at the Institut National Recherche Biomédicale (INRB) lab in DR Congo.

## IMPACT

- **10 trained** in One Health skills
- **346 individuals sampled** (wildlife)
- **125 individuals interviewed** in behavioral risk investigations
- **4,461 tests** for 5 viral families
- **69 viruses** detected

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## VIRAL FINDINGS

| PREDICT-1 | PREDICT-2 |
|---|---|
| **55** NEW VIRUSES | **1** KNOWN VIRUSES |
| **13** KNOWN VIRUSES | |

# PREDICT/Republic of Congo

## Success stories

### Response to Monkeypox outbreak in Likouala

Following the outbreak of Monkeypox in Likouala Province in the Republic of Congo (RoC) that started on the 27th of January 2017, PREDICT/RoC liaised with the Department of Epidemiology and Disease Control within the Ministry of Public Health to provide coordination support for surveillance and community sensitization on Monkeypox disease control and prevention. The outbreak resulted in a total of 61 suspected cases (six confirmed) and four deaths within the villages of Enyellé, Bétou, Manfouété, Dongou, and Impfondo among humans between 4-40 years of age. PREDICT rapidly responded to ministry partner requests to provide essential biosafety equipment (PPE such as gloves, goggles, N95 masks, protective coats, and hand sanitizer) to outfit response teams. This outbreak response was done through the establishment of an International Health Regulations Committee, chaired by the Director General of Epidemiology and Disease control and response, which will continue to act as a multi-sectoral committee for preparedness and response to disease outbreaks in RoC.

### Strengthening One Health surveillance through behavioral risk investigations

Following approval of the human surveillance protocol from the Ethical Committee for Health Science Research in the Republic of Congo in January 2017, two local team members were recruited and trained to conduct behavioral risk investigations in four bushmeat markets (Ouenze, Totale, Bourreau, and Mikalou) and bushmeat restaurants in

*Bushmeat for sale at Marche Totale, where PREDICT/RoC is conducting research around behaviors that increase risk of inter-species disease transmission. Photo credit Leilani Francisco/Ecohealth Alliance.*

Brazzaville, part of a multi-national and in-depth behavioral risk project investigating risks for zoonotic disease transmission along the bushmeat value chain in Central Africa. These markets constitute an important animal value chain interface, as hunted animals in the surrounding villages are sold in these markets. Both team members have significant experience in qualitative research through the USAID Emerging Pandemic Threat's PREVENT project, a foundation PREDICT is building on to advance in-country capacity for

mixed methods behavioral science and analytics through weekly training and mentorship from the global team. Trainings focused on how to conduct mixed methods behavioral risk work, including ethnographic interviews, focus group discussions, human questionnaires, and data management. Qualitative research in RoC was launched in March 2017.

### Reinforcing government laboratory capacity

This project year, PREDICT/RoC worked to outfit and train staff at the national public health lab in RoC (Laboratoire National de Santé Publique, or LNSP). Laboratory equipment and supplies were procured throughout 2017, and the PREDICT team supported staff at LNSP to oversee quality control of the equipment and implement laboratory protocols and standardization.

## Laboratory systems

To date, all animal specimen testing has been conducted by partners at the Institut National Recherche Biomédicale (INRB) lab in the Democratic Republic of the Congo. Capacity is currently being strengthened at the Laboratoire National de Santé Publique (LNSP), where testing may be conducted in the future.

### Implementing partners

EcoHealth Alliance (EHA), Laboratoire National de Santé Publique (LNSP), Metabiota (MB)

### Contact

**Global Point of Contact**: William Karesh, EcoHealth Alliance (karesh@ecohealthalliance.org)

# RWANDA

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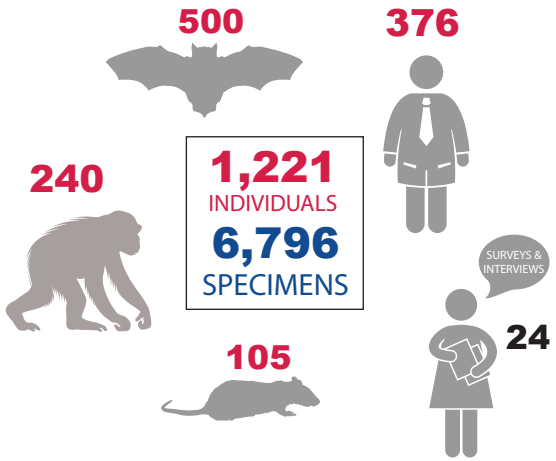
## WORKFORCE DEVELOPMENT

| 6 | 2 | 8 |
|---|---|---|
| STAFF | STUDENTS | GOVERNMENT* |

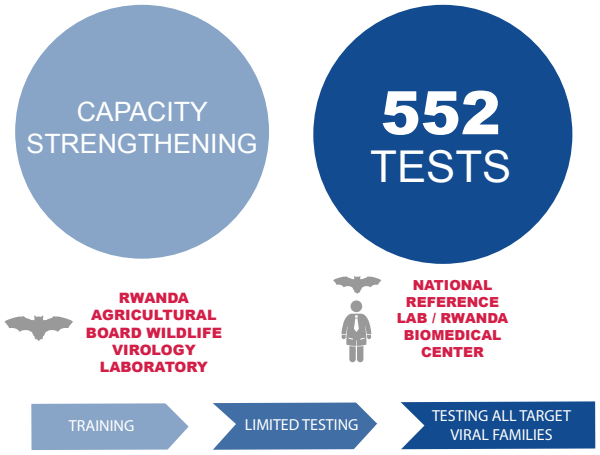
10 MALE | 6 FEMALE

** Not mutually exclusive*

## ONE HEALTH SURVEILLANCE




## LAB STRENGTHENING




## IMPACT

**16 trained** in One Health skills

**1,221 individuals sampled** (humans and animals)

**552 tests** for 4 viral families

**32 viruses** detected

www.predict.global

## VIRAL FINDINGS

| PREDICT-1 | | PREDICT-2 | |
|---|---|---|---|
| 16 NEW VIRUSES | | 1 NEW VIRUS | |
| | | 1 PREDICT-1 VIRUS | |
| 11 KNOWN VIRUSES | | 3 KNOWN VIRUSES | |

# PREDICT/Rwanda

## Success stories

### Launch of concurrent One Health surveillance in Musanze District, Northern Province

PREDICT/Rwanda launched human syndromic surveillance at health facilities surrounding Volcanoes National Park, collecting biological samples and administering a human questionnaire to explore behaviors and practices that may be associated with exposure to zoonotic diseases. PREDICT completed questionnaires and collected samples from 400 febrile patients presenting at Ruhengeri Referral Hospital, Kinigi Health Center, Shingiro Health Center, and Bisate Health Center. Concurrently, PREDICT continued to collect samples from wildlife (bats, nonhuman primates, and rodents) utilizing human dwellings, croplands and tourism sites in the communities that are served by these health centers, where there is a high level of contact between wildlife and people. Hundreds of wildlife samples have been extracted in preparation for viral testing for priority zoonotic diseases (e.g., influenza, and the hemorrhagic fevers) and other emerging threats by PREDICT project staff working at Rwanda Agriculture Board (RAB) Wildlife Virology Laboratory. Human specimens have been submitted to the National Reference Lab at the Rwanda Biomedical Center (RBC/NRL) in preparation for testing. Additionally, PREDICT's global reference lab at the UC Davis One Health Institute is assisting PREDICT/ Rwanda with viral family screening of hundreds of additional wildlife samples collected to date.

*The Rwanda Human Surveillance Technician collects an oral swab from febrile patient. Photo credit: PREDICT/Rwanda*

### Supporting outbreak response and risk communication

Following an outbreak of highly pathogenic avian influenza in neighboring Uganda and reports of a wild bird die-off in Rusizi District, PREDICT assisted the Ministries of Agriculture and Health and the Rwanda One Health Steering Committee (ROHSC) with a field investigation targeting wild birds in Western Province. Though no dead birds were observed or sampled during the trip, PREDICT contributed to the government's public sensitization campaign on avian influenza by informing local communities about disease prevention through local and national radio shows. In addition, PREDICT participated in a two-day workshop organized by the Ministry of Agriculture to update the national contingency plan for Avian Influenza.

### Strengthening regional One Health networks for improved zoonotic disease surveillance

As part of PREDICT's strategy for strengthening regional networks for One Health and zoonotic disease surveillance across Africa, the PREDICT/Rwanda team hosted PREDICT team members from Senegal for an intensive field training to share best practices. During the training, the visiting PREDICT teams received hands-on instruction in critical skills required for implementation of zoonotic disease surveillance activities. Practical sessions focused on biosafety, safe wildlife capture and sampling, human syndromic surveillance, cold chain, sample storage and transport, and data management. PREDICT Rwanda then travelled to Senegal in August to provide *in situ* training on wildlife sampling. As a result, the PREDICT/Senegal team has increased their capacity to conduct planned field activities at surveillance sites and plans to transfer these skills and knowledge to local partners and government staff.

### Prioritizing zoonotic diseases

PREDICT participated in the One Health Zoonotic Disease Prioritization workshop organized by the US Centers for Disease Control. Several diseases prioritized for application of One Health approaches to control and prevention are caused by viruses in the families actively tested by PREDICT/Rwanda partner labs (e.g. influenza, and the hemorrhagic fevers). In addition, PREDICT contributed and helped identify workforce gaps for priority zoonotic disease investigation and outbreak response at the ROHSC's One Health Systems Mapping and Analysis Resource (SMART) workshop for mapping cross-sectoral collaboration for prioritized zoonotic disease investigation, held by the One Health Central-East Africa (OHCEA) network.

### Training tomorrow's One Health leaders

Members of the PREDICT team helped host and teach the inaugural Rx One Health course in Rwanda, organized by the UC Davis One Health Institute in collaboration with the University of Rwanda and the PREDICT/Tanzania team based at Sokoine University of Agriculture. The goal of the 4-week course held in June was to provide 21 early career professionals from Rwanda, Tanzania, Nepal, Denmark, and the US with the knowledge, skills and mentors needed to immediately engage in One Health careers.

## Laboratory systems

PREDICT/Rwanda partners with the Rwanda Agriculture Board (RAB) Wildlife Virology Laboratory and the National Reference Lab at the Rwanda Biomedical Center (RBC/NRL) and together the labs implement viral testing of animal and human samples for priority zoonotic diseases and other emerging threats in five viral families (influenza, filo-, corona- and paramyxovirus).

### Implementing partners

UC Davis, Mountain Gorilla Veterinary Project (MGVP), Inc., Rwanda Agriculture Board, and Rwanda Biomedical Center/National Reference Laboratory.

## Contacts

**Country Coordinator:** Julius Nziza, MGVP
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**Global Points of Contact**: Kirsten Gilardi, UC Davis
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# SENEGAL

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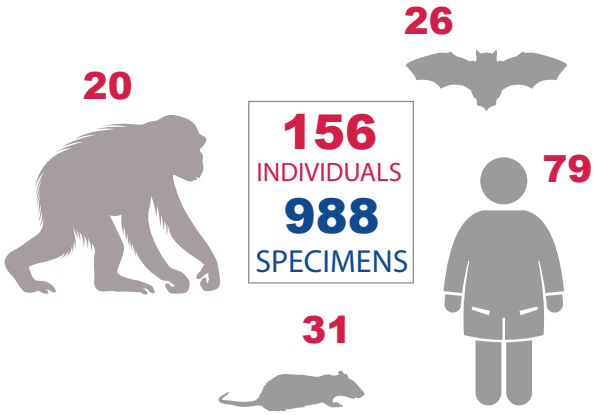
Global Health Security Agenda

## WORKFORCE DEVELOPMENT

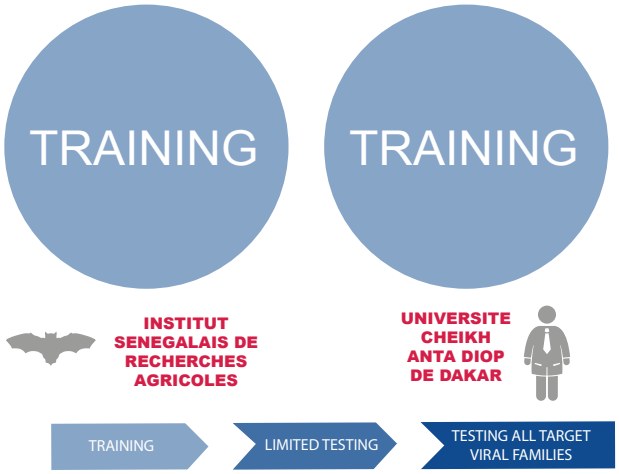
| 13 | 4 | 2 |
|---|---|---|
| STAFF | GOVERNMENT | OTHER |

14 MALE | 5 FEMALE

## ONE HEALTH SURVEILLANCE




## LAB STRENGTHENING




## IMPACT

**19 trained** in One Health skills

**156 individuals sampled** (humans and animals)

**Training initiated** for viral testing

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PREDICT/Senegal team samples an Eidolon species fruit bat during a training session.
*Photo: Chris Kilonzo*

# PREDICT/Senegal

## Success stories

### Strengthening One Health networks for improved Global Health Security in West Africa

PREDICT/Senegal participated in multiple trainings to reinforce capacity, as part of the strategy for strengthening regional networks for One Health and improved security for zoonotic disease prevention, detection, and response in Africa. Fostering regional collaborations and international relations, the PREDICT/Senegal team received hands-on instruction and mentorship from the PREDICT/Rwanda and Tanzania surveillance leads on critical skills required for implementation of surveillance activities. Through active participation, several representatives from the Direction des Parcs Nationaux (DPN), a PREDICT partner within the ministry responsible for wildlife, also attended the training, to assist zoonotic disease surveillance activities and to build capacity for improved disease detection in regional and local departments in the animal health sector.

In addition, members of the wildlife team, including three veterinarians from the Inter State School of Veterinary Science and Medicine of Dakar (EISMV), travelled to Sierra Leone for a joint field surveillance workshop with PREDICT/Guinea and Sierra Leone teams. Participants received intensive instruction on field site management, biosecurity, data quality assurance, and rodent, bat, and non-human primate sampling techniques. As a result of these regional collaborations, The PREDICT/Senegal team is better equipped to conduct field activities, and to transfer core One Health skills and knowledge to local partners and government staff, in addition

*A PREDICT/Senegal health professional collects a sample during syndromic surveillance at the Sindia Health Post. Photo credit: PREDICT/Senegal.*

to benefiting from a broad and collective One Health network. Going forward, Senegalese health professionals are competent leaders in biosafety, safe wildlife capture and sampling, human syndromic and community surveillance, sample storage and transport, and data management.

### Concurrent animal-human surveillance and community engagement

A collaborative team including PREDICT/Senegal human and wildlife partners, Food and Agriculture Organization (FAO) of the United Nations, USAID/One Health Workforce/OCHEA, DPN, and regional and departmental representatives from the Ministry of Livestock identified and characterized multiple animal-human high-risk interfaces including agricultural intensification, hunting, and ecotourism in the Sindia region. Given the proximity of these interfaces to heavily populated areas, including the capital city, Dakar, and potential pathogen spillover and spread, partners collectively agreed to focus

concurrent One Health surveillance efforts in and around the Sindia clinic, Bandia Reserve and surrounding villages.

PREDICT then developed joint human and animal surveillance plans in collaboration with local focal points. Working together, PREDICT, and Government of Senegal partners established relationships with the Sindia Health Post personnel, local Community Health Workers, as well as community leads. The team carried out community sensitization and engagement in three villages, Sindia, Bandia, and Kiniabour, as well as the Bandia Reserve. As a result of community engagement and the relationships established by the multi-sectoral team, PREDICT successfully launched concurrent human and animal surveillance activities in the Sindia region.

### Increasing capacity in the national laboratory network

PREDICT partner labs at the Senegalese Agriculture Research Institute (ISRA), and the University Cheikh Anta Diop (UCAD) were trained and equipped in the full range of activities required for safely detecting zoonotic viruses, including biosafety and biosecurity and molecular viral detection techniques. As a result, both labs have capacity to safely detect priority zoonotic diseases (Rift Valley Fever, and zoonotic influenza viruses) and emerging viral threats, and to serve as key training centers for students and professionals, including government staff from the national lab system.

### Partnerships and workforce development

Sub-award agreements were established with three key partners in Senegal to formalize PREDICT's One Health team: a regional veterinary school (EISMV) and medical school (UCAD), both of which serve as key training centers for Senegal's health workforce, and a national reference laboratory (ISRA). A total of 19 PREDICT team members have been trained in up to 20 project protocols including biosafety and biosecurity, safe wildlife capture and sampling, human syndromic surveillance methods, sample storage and transport, cold chain, data management, and viral detection techniques. Key personnel have successfully completed all trainings and are now qualified to train others.

## Laboratory systems

PREDICT/Senegal partners with laboratories at the Senegalese Institute of Agriculture Research (ISRA – animal) and the University of Cheikh Anta Diop (UCAD – human) to strengthen national capacity to begin testing for priority zoonotic diseases (e.g., Rift Valley Fever, and zoonotic influenza viruses) and emerging viral threats across four viral families (influenza, filo-, corona- and paramyxovirus).

### Implementing partners

UC Davis, Inter State School of Veterinary Science and Medicine of Dakar (EISMV), Cheikh Anta Diop University/Dantec University Hospital (UCAD), Senegalese Institute of Agricultural Research/National Livestock and Veterinary Research Laboratory (ISRA/LNERV).

### Contacts

**Principal Investigators:** Dr. Yaghouba Kane, EISVM (ykane00@yahoo.fr); Dr. Daouda N'diaye, UCAD; (daouda.ndiaye@ucad.edu.sn), Dr. Modou Moustapha Lo, ISRA (moustaphlo@yahoo.fr)

**Global Point of Contact**: Dr. Corina Monagin, UC Davis (cgmonagin@ucdavis.edu)

# SIERRA LEONE

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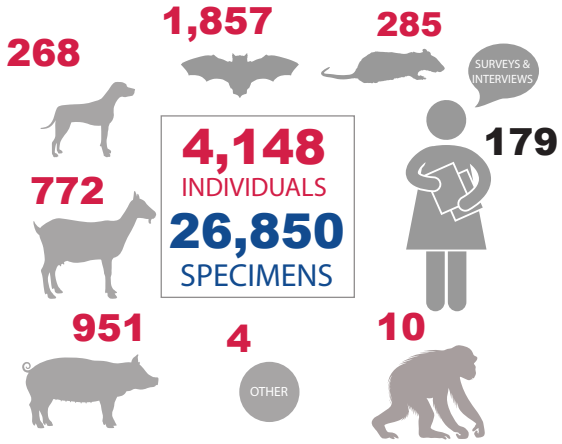
## WORKFORCE DEVELOPMENT

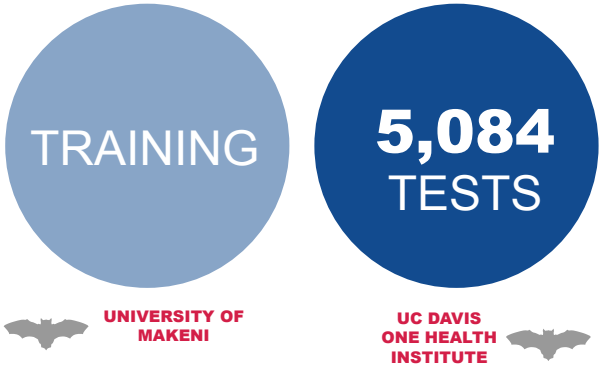
| 28 | 56 | 58 |
|---|---|---|
| STAFF | GOVERNMENT | OTHER |

36 MALE | 12 FEMALE

## ONE HEALTH SURVEILLANCE




## LAB STRENGTHENING




TRAINING → LIMITED TESTING → TESTING ALL TARGET VIRAL FAMILIES

*As part of the Ebola Host Project, samples are being tested at Columbia University to accelerate release of viral findings for use for decision-making and risk mitigation efforts.

## IMPACT

**48 trained** in One Health skills

**4,148 individuals sampled** (wildlife and domestic animals)

**179 individuals interviewed** in behavioral risk investigations

**5,084 tests** for Ebola and other filoviruses

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Safe animal capture and sampling training for the Ebola Host Project. *Photo: PREDICT/Sierra Leone*

## PREDICT/Sierra Leone

**Sierra Leone is implementing the Ebola Host Project along with PREDICT teams in Guinea and Liberia.*

## Success stories

### Strengthening surveillance and detection for priority zoonotic diseases

PREDICT/Sierra Leone continues to work in collaboration with local and national organizations, including the University of Makeni, Sierra Leone Ministries of Health and Agriculture, USIAD/Preparedness & Response (P&R), the US Centers for Disease Control (CDC), as well as the Food and Agriculture Organization (FAO) and World Health Organization (WHO) of the United Nations.

In June 2017, twelve individuals from the PREDICT/Sierra Leone team, the University of Makeni, Ministry of Health and Safety (MAHS) and Ministry of Agriculture, Forestry, and Food Security (MAFFS) laboratory staff successfully completed a two-week hands-on training workshop on laboratory best practices and disease detection techniques using PREDICT protocols for filoviruses, which are designed to detect ebolaviruses, a priority zoonotic disease in Sierra Leone, along with other potentially unknown members of this viral family. The workshop helped strengthen inter-linkages between Sierra Leone's animal and human health lab systems and enhanced capabilities for filovirus diagnostics. Continued mentorship and support will be provided for further in-country testing of livestock specimens at the PREDICT partner laboratory based at the University of Makeni.

In addition, PREDCT/Sierra Leone worked to foster government partnerships and expand the health workforce for safe surveillance of Ebola virus and other high-consequence

*A member of the PREDICT team speaks at a community engagement meeting in Makeni, March 28th, 2017. Photo credit: PREDICT/Sierra Leone.*

pathogens. This year, PREDICT provided training to six wildlife officers on biosafety and PPE use and safe animal sampling protocols and operating procedures in Kono, Koinadugu, and Kambia districts. The officers are district level employees of the MAFFS in the wildlife division and were nominated by their Director to be trained and work with the PREDICT team. These officers will continue to work with PREDICT, gaining additional experience putting these critical skills into practice.

### Supporting subnational and national One Health platforms

PREDICT supported multi-sectorial coordination mechanisms for zoonotic disease prevention by successfully holding three district level One Health platform initiation meetings in Kono, Koinadugu, and Kambia districts in November 2016. Together

with district medical and agriculture officers, PREDICT field staff discussed coordination mechanisms for zoonotic disease surveillance and how to strengthen the One Health platform at the district level. PREDICT also met with the USAID/P&R team to discuss 'Terms of References' for the One Health committees and identified next steps for the coordination of national One Health initiatives. Subsequently, PREDICT attended the National One Health technical committee meeting in Freetown on December 20th, 2016 to review the One Health platform's coordination structure and finalization of functions. In addition, the PREDICT team participated in a three-day workplan development and launch of the World Bank Regional Disease Surveillance Strategy Enhancement (REDISSE) project, contributing expert knowledge on the prioritization and implementation of REDISSE activities in Sierra Leone.

### Working with local stakeholders to prevent and detect zoonotic disease threats

This year, PREDICT's locally-based Sierra Leone team successfully collected over 26,000 samples from more than 4,000 animals (bats, rodents, goats, sheep, dogs, cats, non-human primates, and pigs) at high-risk disease transmission interfaces. In addition, the team conducted behavioral risk investigations in Western Area, Koinadugu, and Bombali districts to identify behavioral factors associated with risks of disease transmission along with potential prevention strategies. In total, the team interviewed 179 individuals (103 ethnographic interviews, 12 targeted questionnaires, and six focus group discussions) working in high-risk occupations, such as bat hunters, bushmeat traders, and livestock producers.

In September 2017, the PREDICT team conducted site scoping visits to areas in Pujehun with a high-risk of zoonotic disease transmission. In collaboration with district Ministry of Health and Ministry of Agriculture staff, bat and non-human primate interfaces were identified for inclusion in ongoing zoonotic disease surveillance activities. Further engagement of these communities is planned as part of ongoing work to link field-based activities with community outreach and education on risks of disease transmission and spread. To that end, PREDICT coordinated end of year regional and community-level meetings with over 200 key district, chiefdom, and community level stakeholders in all operational areas. These meetings provided the opportunity to discuss progress and plans, conduct outreach on disease transmission risks and mitigation practices, and collect valuable stakeholder feedback to improve project efficacy.

## Laboratory strengthening

As part of the Ebola Host Project, wildlife samples are being tested at PREDICT's global reference lab at the University of California, Davis One Health Institute to accelerate release of viral findings for use for decision making and risk mitigation efforts. PREDICT's partner lab at the University of Makeni has received training in detection of ebolaviruses and other threats and is preparing to test livestock samples in Sierra Leone as part of efforts to strengthen national laboratory capabilities.

### Implementing partners

UC Davis, University of Makeni

### Contacts

**Country Coordinator:** Professor Aiah Gbakima (Gbakimaaa2006@gmail.com)

**Global Point of Contact:** Dr. Brian Bird (bhbird@ucdavis.edu)

# TANZANIA

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Global Health Security Agenda

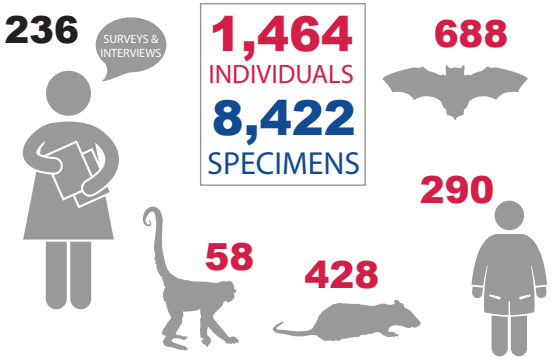
## WORKFORCE DEVELOPMENT

| 19 | 26 | 12 | 7 |
|---|---|---|---|
| STAFF | STUDENTS | GOVERNMENT | OTHER |

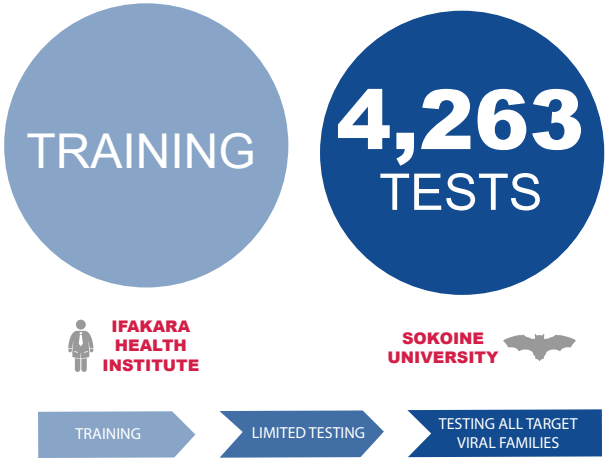
23 MALE | 32 FEMALE

*9 individuals gender not recorded

## ONE HEALTH SURVEILLANCE




## LAB STRENGTHENING




## IMPACT

**64 trained** in One Health skills

**1,424 individuals sampled** (humans and animals)

**236 individuals interviewed** in behavioral risk investigations

**4,263 tests** aimed at detecting Ebola, Marburg, and zoonotic influenza viruses

**62 viruses** detected

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## VIRAL FINDINGS

**50**
NEW VIRUSES

**12**
KNOWN VIRUSES

**PREDICT-1**

## PREDICT/Tanzania

## Success stories

### One Health surveillance and workforce development to improve zoonotic disease prevention, detection, and response capacity

The PREDICT team engaged community members in zoonotic disease outreach and project sensitization meetings reaching 355 community leaders and representatives from 14 villages in the Kagera and Kigoma regions. At the meetings, community members were introduced to PREDICT's One health approach to surveillance the relevance of appropriate biosafety and biosecurity practices and basic disease prevention practices. Following the meetings, in August 2017, the PREDICT team successfully launched concurrent One Health surveillance of people and wildlife in six villages in the Kibondo district in northwest Tanzania, an area considered a hot spot for disease emergence where people live in proximity to wildlife near a rapidly expanding settlement that hosts refugees from neighboring Burundi and the Democratic Republic of Congo. A total of 102 people and 242 animals (82 rodents, 82 bats) were sampled and behavioral risk interviews conducted, the first of multiple sampling trips designed to investigate seasonal patterns of zoonotic disease transmission.

During the trip, PREDICT continued to strengthen in-country capacity to tackle zoonotic diseases through in-service training for local and government animal health staff, including district veterinary officers and community-based stakeholders. These trainings aimed to enhance core One Health professional skills required for conducting field investigations (outreach on zoonotic disease risks, biosafety and PPE, safe sample collection from wildlife and people, cold chain, safe sample storage and transport, behavioral risk investigations, and data management).

*Two students from the Sokoine University of Agriculture work alongside PREDICT/Tanzania staff to collect non-invasive samples from an urban fruit bat colony. The PREDICT/Tanzania team has been training students, the future One Health workforce, in critical One Health skills required for safe zoonotic disease surveillance and detection. Photo: Abel Ekiri, PREDICT/Tanzania.*

In addition, the PREDICT/Tanzania team continued to strengthen local health centre capability for conducting zoonotic disease surveillance in Ujiji, also in the Lake Zone region of northwest Tanzania. Twelve Ujiji Health Centre staff received training in ethics, safe sample collection, cold chain, and data management in preparation for launch of syndromic surveillance targeting patients with undiagnosed fevers that may be associated with priority zoonotic diseases. Following the training, 200 patients that presented with fever at Ujiji

Health Centre, Kigoma Region were successfully enrolled and sampled.

### Supporting national prioritization of zoonotic diseases

PREDICT/Tanzania's Principal Investigator helped facilitate the multi-sectoral One Health zoonotic disease prioritization workshop held March 23-24, 2017 in Dar es Salaam. In addition to workshop facilitation, PREDICT worked together with US interagency partners (USAID and CDC) and the Tanzania One Health Coordination Unit in preparation and planning for the workshop and provided technical assistance, expertise, and informational resources on endemic and emerging zoonotic viral threats in Tanzania and the greater Africa region to workshop organizers. As a result of the workshop, Tanzania identified rabies, Rift Valley Fever and other hemorrhagic fevers (Marburg and Ebola), zoonotic influenza virus, anthrax, human African trypanosomiasis, and Brucellosis as priority zoonotic diseases and will be developing surveillance and lab capacities as relevant.

### Training tomorrow's One Health leaders

Members of the PREDICT/Tanzania team helped host and teach the inaugural Rx One Health course in Tanzania, organized by the UC Davis One Health Institute in collaboration with the Sokoine University of Agriculture and University of Rwanda. The goal of the 4-week course held in Tanzania and Rwanda in June 2017 was to provide 21 early career professionals from Tanzania, Rwanda, Nepal, Denmark and the US with the knowledge, skills and mentors needed to immediately engage in One Health careers.

## Laboratory systems

PREDICT/Tanzania is partnering with the Sokoine University of Agriculture (SUA) for animal testing and the Ifakara Health Institute (IHI) for human testing. SUA is implementing viral family testing for all five priority viral families and using techniques that can detect priority zoonotic diseases (Rift Valley Fever and other hemorrhagic fevers and zoonotic influenza virus). IHI has launched viral family testing and is now sharing preliminary findings with the SUA and UC Davis teams as capacity is developed.

Both labs maintain linkages with the national laboratory system and act as reference centers upon request. The SUA lab is coordinating with the Tanzania Veterinary Laboratory Agency (TVLA) and FAO on the potential for training and testing of livestock samples using project protocols.

### Implementing partners

UC Davis, Sokoine University of Agriculture (SUA), and Ifakara Health Institute (IHI)

### Contacts

**Principal Investigator:** Professor Rudovick Kazwala, SUA (Kazwala@gmail.com)

**Country Coordinator:** Dr. Zikankuba Sijali, SUA (zikankubasijali@gmail.com)

**Global Point of Contact**: David Wolking, UC Davis (djwolking@ucdavis.edu)

# UGANDA

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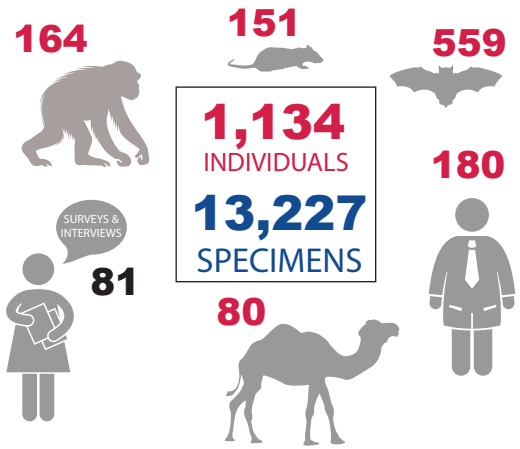
Global Health Security Agenda

## WORKFORCE DEVELOPMENT

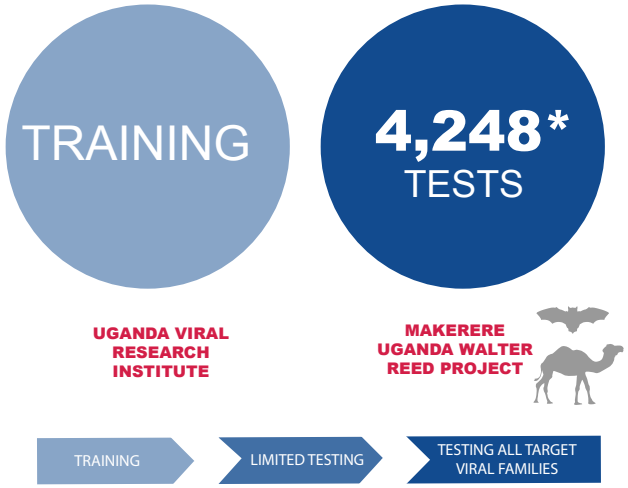
| 3 | 8 | 1 |
|---|---|---|
| STAFF | GOVERNMENT | OTHER |

6 MALE | 6 FEMALE

## ONE HEALTH SURVEILLANCE




## LAB STRENGTHENING




*No longer actively engaged.

## IMPACT

**12 trained** in One Health skills

**1,134 individuals sampled** (humans and animals)

**81 individuals interviewed** in behavioral risk investigations

**4,248 tests** for10 viral families aimed at detecting hemorrhagic fevers (Ebola, and Marburg), and zoonotic influenza

**56 viruses** detected

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## VIRAL FINDINGS

**39**
NEW
VIRUSES

**17**
KNOWN
VIRUSES

PREDICT-1

# PREDICT/Uganda

## Success stories

### Identification of a new coronavirus closely related to MERS CoV

Based on work conducted by the PREDICT/Uganda team, a publication co-authored by Ugandan team members was published in the journal *mBio*. The paper, entitled “Further evidence for bats as the evolutionary source of MERS Coronavirus”, describes a new coronavirus detected in a bat in Uganda, and sheds light on bats as the potential reservoir for emerging infectious diseases like Middle Eastern Respiratory Syndrome (MERS) Coronavirus.

### Supporting national prioritization of zoonotic diseases

PREDICT participated in and contributed to several One Health zoonotic disease prioritization meetings held throughout the year in support of the GHSA Zoonotic Diseases Joint External Evaluation process. Five priority zoonotic diseases were selected by the government ministries of Health, Agriculture, and the Environment with support from partners. In collaboration with government partners at district to national levels, PREDICT is working to strengthen detection and response capacity for several priority diseases, including viral hemorrhagic fevers and zoonotic influenza viruses.

### Strengthening the National One Health Platform

PREDICT participated in the inaugural meeting of the National One Health Technical Working Group (OHTWG) in Kampala, a prelude to the formal launch of the National One Health

*A map showing the distribution of the bat species from which the new coronavirus closely related to MERS-CoV was detected. Source: mBio* [http://mbio.asm.org/content/8/2/e00373-17](http://mbio.asm.org/content/8/2/e00373-17)

Platform (NOHP). The NOHP is a multi-sectoral and multidisciplinary collaboration between the Ministry of Agriculture, the Ministry of Health, the Ministry of Water and Environment, and the Uganda Wildlife Authority. The NOHP was established to provide technical guidance to the government in the implementation of the One Health approach to strengthen cross-sectoral collaboration to prevent, detect, and respond to zoonotic and other emerging health threats. As a member of the NOHP’s OHTWG, PREDICT continues to provide technical input and expertise on zoonotic disease surveillance and preparedness to the working group and government partners.

## One Health surveillance at high-risk interfaces

Using a One Health approach, PREDICT commenced human syndromic surveillance at Bwindi Community Hospital (BCH) in Buhoma, Kanungu District, southwestern Uganda, an area identified as high-risk area for zoonotic disease transmission. BCH receives patients with febrile illnesses, many of which go undiagnosed and are of unknown origin. PREDICT's syndromic surveillance design involves biological sample collection coupled with a semi-structured human questionnaire to explore behaviors and practices that may be associated with exposure to zoonotic diseases. At BCH, PREDICT conducted in-service trainings for clinic staff in ethics, biosafety, safe sample collection, cold chain, data management, and administration of the behavioral questionnaire. Following training, clinic staff sampled and obtained behavioral risk data from febrile patients presenting from communities in the greater Bwindi-Mgahinga Conservation Area. Concurrently, PREDICT continued wildlife surveillance at high-risk animal-human interfaces in communities adjacent to Bwindi Impenetrable National Park in Rubanda and Kanungu districts that are served by BCH, collecting samples from bats, rodents, and non-human primates encountered in and around human dwellings and croplands.

## Strengthening linkages between Africa's One Health workforce

Building regional relationships between countries in support of improving networks to strengthen Africa's One Health workforce, PREDICT/Uganda hosted PREDICT/Ghana team members and provided *in situ* training on zoonotic disease surveillance activities, focusing on ethical and practical implementation of human syndromic surveillance protocols.

# Laboratory systems

PREDICT/Uganda engaged a new laboratory partner, the Uganda Viral Research Institute (UVRI), a critical node in Uganda's national laboratory system. The UVRI laboratory is preparing to test human and animal samples by PCR to detect priority zoonotic diseases and other emerging threats from five viral families (corona -, filo-, influenza-, paramyxo- and flaviviruses).

## Implementing partners

UC Davis, Mountain Gorilla Veterinary Project (MGVP), Inc., Uganda Viral Research Institute (UVRI)

## Contacts

**Country Coordinator:** Benard Ssebide, MGVP (bssebide@gorilladoctors.org)

**Global Points of Contact**: Kirsten Gilardi, UC Davis (kvgilardi@ucdavis.edu) and Michael Cranfield, UC Davis (mrcranfield@gorilladoctors.org)

# BANGLADESH

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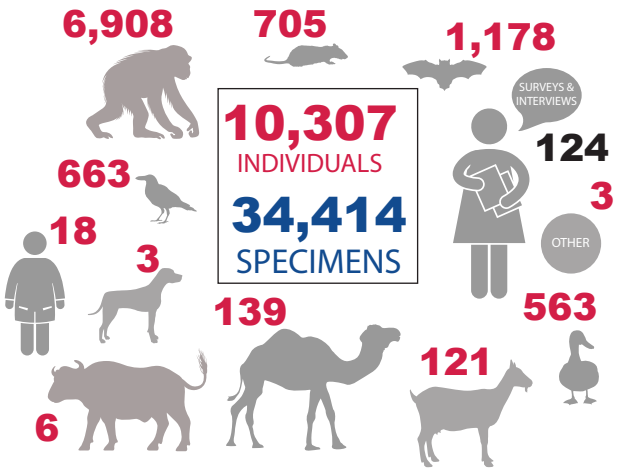
Global Health Security Agenda

## WORKFORCE DEVELOPMENT

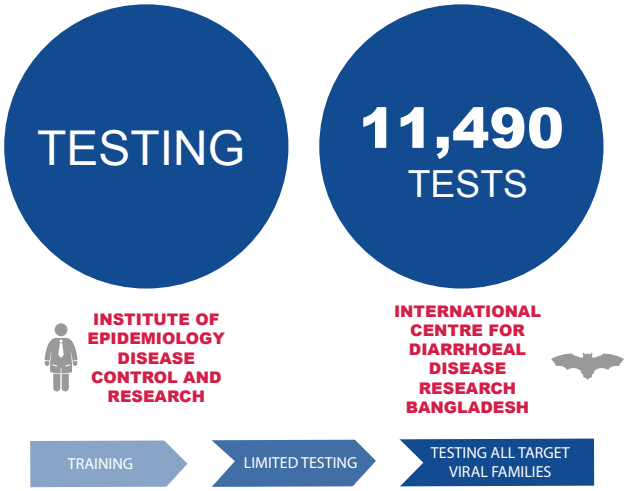
| 25 | 74 | 10 | 5 |
|---|---|---|---|
| STAFF | STUDENTS | GOVERNMENT | OTHER |

89 MALE | 25 FEMALE

## ONE HEALTH SURVEILLANCE




## LAB STRENGTHENING




## IMPACT

- **114 trained** in One Health skills
- **10,307 individuals sampled** (humans and animals)
- **124 individuals interviewed** in behavioral risk investigations
- **11,490 tests** for 5 viral families
- **237 viruses** detected

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## VIRAL FINDINGS

**217**
NEW
VIRUSES

**20**
KNOWN
VIRUSES

**PREDICT-1**

# PREDICT/Bangladesh

## Success stories

### Outbreak response support

PREDICT/Bangladesh plays a critical role in outbreak response support to the Government of Bangladesh's national health system through field-based zoonotic disease investigations and viral detection at partner laboratories. In addition to regularly planned One Health surveillance activities, the PREDICT team was engaged by ministry partners multiple times over a four-month period to help identify the cause of disease outbreaks in wildlife and in humans, as described below.

In January, the Director of the Rajshahi Medical College Hospital (RMCH) notified the Institute of Epidemiology, Disease Control and Research (IEDCR) about an unusual crow die-off in the vicinity of the hospital. Concurrently, PREDICT observed sick and dying crows during bat surveillance activities in Dhaka. IEDCR requested PREDICT's expertise in order to investigate the geographical distribution, cause, and any epidemiological links between the two outbreaks. PREDICT provided technical guidance and collected samples from; wild birds, feral dogs, crow feces from under roosts, poultry offal at local markets, and fecal samples from poultry farms. The team also conducted qualitative interviews and some laboratory testing in conjunction with the Department of Livestock Services' (DLS) federal reference laboratory, Bangladesh Livestock Research Institute (BLRI). The causative agent was identified as highly pathogenic avian influenza. PREDICT's participation in the response effort improved understanding of avian influenza viral diversity and

*PREDICT inspects a dead crow during the investigation of an unusual die off. Photo credit: PREDICT/Bangladesh.*

the risk of zoonotic disease emergence across disease transmission pathways in susceptible wild bird species in Bangladesh.

In a separate incident, IEDCR notified PREDICT of three human encephalitis cases suspected to be associated with Nipah virus infection in Faridpur and Pabna. IEDCR requested PREDICT's technical assistance in a One Health investigation to conduct wildlife and domestic animal sampling. PREDICT collected samples from bats in Faridpur and all animal samples were transferred the PREDICT partner laboratory, icddr,b for testing using specific PCR tests for Nipah virus, PREDICT's paramyxovirus family testing, and other priority viral families. All findings will be released when approved by Government of Bangladesh partners.

### Strengthening the health workforce and improving One Health networks in South Asia

In March and April, PREDICT organized and facilitated a three field workshops to support improved workforce capacity for wildlife disease surveillance in the South Asia region. As part of PREDICT's strategy to foster active One Health networks among professionals globally, participants from PREDICT/India joined two Forestry Officers from the Government of Bangladesh for extensive training on the safe capture, immobilization, handling, and sampling of rhesus macaque, bats, and rodents. The workshops highlighted and emphasized the proper use of personal protective equipment while in the field to ensure the safety of both field researchers and animals. In addition, PREDICT engaged and trained health professionals at local hospitals and universities to implement human behavioral, syndromic, and community surveillance for zoonotic spillover at sites where current wildlife sampling is occurring, in order to discern potential zoonotic disease transmission pathways.

In collaboration with FAO and the Department of Livestock Services, PREDICT mapped animal transportation and sale along the boarder between Bangladesh and India. The maps generated will be used to create a single combined Bangladesh-India Transboundary Animal Value Chain map, and will be used by the government to improve understanding of animal movement, and help to identify risk of zoonotic disease transmission in order to target future surveillance.

### One Health Economics Fellow

PREDICT/Bangladesh welcomed a new team member, Dr. Jinnat Ferdous, as the inaugural PREDICT One Health Economics Fellow. Dr. Ferdous obtained her Doctor of Veterinary Medicine and Masters in Veterinary Epidemiology Chittagong Veterinary and Animal Sciences University. Working closely with IEDCR and the One Health Secretariat of Bangladesh, her analysis aims to assess the economic burden of zoonotic diseases to individual households and the public and private sectors, including a cost analysis of disease avoidance behaviors. By incorporating the results into the Government of Bangladesh's strong One Health focus, PREDICT will contribute to the development of future disease prevention and control strategies that optimize resource allocation to promote 'whole-of-society' benefits.

## Laboratory systems

PREDICT/Bangladesh is partnering with the laboratory at icddr,b for animal testing. Human testing will be performed by the Institute of Epidemiology, Disease Control and Research (IEDCR). Icddr,b and IEDR are implementing the viral family protocols for five priority families (corona, filo, flavi, influenza, and paramyxo viruses).

### Implementing partners

EcoHealth Alliance, icddr,b, and the Institute of Epidemiology, Disease Control and Research (IEDCR).

### Contacts

**Country Coordinator:** Dr. Ariful Islam, EcoHealth Alliance (arif@ecohealthalliance.org)

**Global Point of Contact:** Jon Epstein, EcoHealth Alliance (epstein@ecohealthalliance.org)

# CAMBODIA

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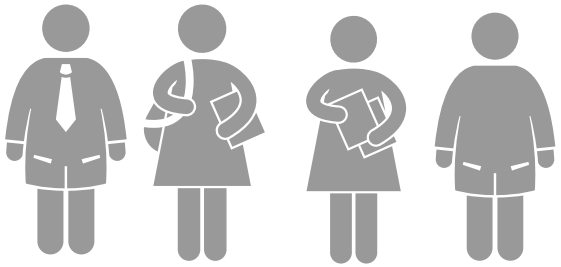
Global Health Security Agenda

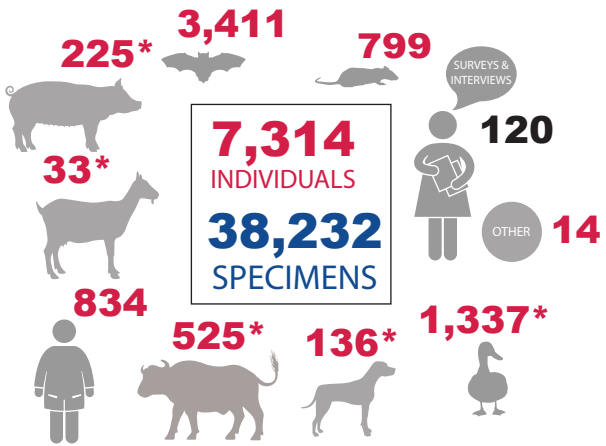
## WORKFORCE DEVELOPMENT

| 10 | 24 | 7 | 14 |
|---|---|---|---|
| STAFF | STUDENTS | GOVERNMENT | OTHER |



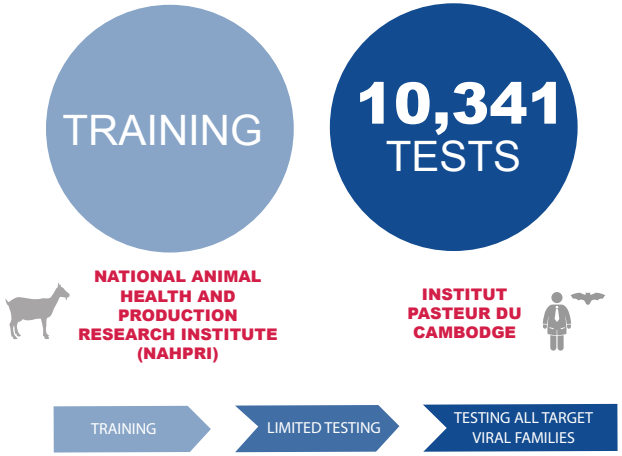
34 MALE | 21 FEMALE

## ONE HEALTH SURVEILLANCE




*Samples collected in collaboration with FAO

## LAB STRENGTHENING




## IMPACT

**55 trained** in One Health skills

**7,314 individuals sampled** (humans and animals)

**954 individuals interviewed** in behavioral risk investigations

**10,341 tests** for 9 viral families

**61 viruses** detected

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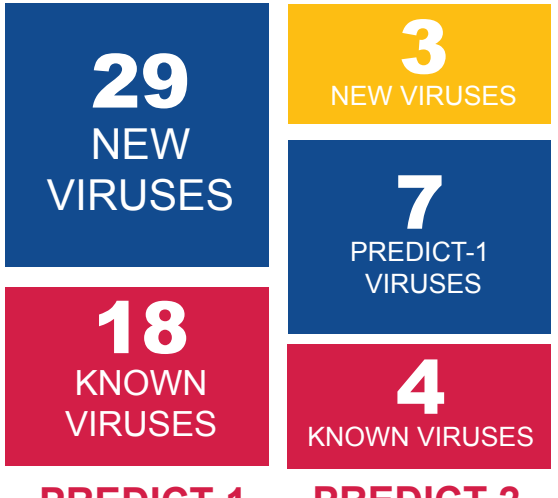
## VIRAL FINDINGS



## PREDICT/Cambodia

## Success stories

### One Health surveillance of people, livestock, and wildlife at high-risk interfaces

Using the One Health approach, PREDICT/Cambodia conducted concurrent sampling of wildlife and humans in both dry and rainy seasons, at two high-risk interfaces for zoonotic disease transmission: an international rodent trading hub in Kandal Province on the border with Viet Nam; and a bat guano farming community in Kampong Cham.

Active engagement and partnership with FAO and the Government of Cambodia human and animal health divisions, including the National Animal Health and Production Research Institute (NAHPRI), the Cambodia Communicable Disease Control Department (CDC), and the Forestry Administration (FA), led to the successful collection of over 1800 samples from wild animals, and recruitment of more than 380 community members working or living in or around high-risk disease transmission interfaces.

In Kandal, PREDICT obtained samples from rats transported from different provinces to a trade hub that were destined for consumption. Concurrently, people working or living in or around the rodent trade markets completed questionnaires and provided specimens. In coordination with FAO, domestic animals, poultry, and livestock were sampled in the vicinity of the rodent trade hub; at a nearby village where trappers and traders live; and at a small-scale local abattoir where local pigs are taken for slaughter.

*PREDICT's One Health field team aliquots samples at the mobile laboratory station during sampling at the rodent trade hub in Kandal province. Photo credit: Lucy Keatts/PREDICT*

In Kampong Cham, artificial bat roosts are used to farm guano. Through consultation with government and local inhabitants, PREDICT identified this interface as a potential route for virus transmission due to the intimate contact between bats and farm workers. As such, PREDICT collected samples for virus testing from free-ranging bats, wild rodents, and humans working and living on the bat guano farms. In addition, FAO targeted poultry and livestock living on or adjacent to the guano farms for concurrent surveillance.

Four hospitals have also been engaged to participate in PREDICT human syndromic surveillance activities, three of which draw patients from the communities where PREDICT has conducted community-based sampling. Samples and surveys were collected from syndromic patients at Kantha Bopha pediatric hospital in Phnom Penh which treats sick children from across the country; Koh Thom district hospital in

Kandal province, close to the rodent trade field sampling site; and Prey Chhor and Roka Kaorng district hospitals, both adjacent to the bat guano farming community.

### Strengthening risk-based surveillance and improved viral detection

Development of capacity to conduct zoonotic disease surveillance and outbreak response has been at the core of PREDICT activities in Cambodia. Educational opportunities were provided to the future workforce, including practical field training for students from the Royal University of Agriculture (RUA), Royal University of Phnom Penh (RUPP) and the University of Health Sciences (UHS).

Engagement of local and regional health facilities has afforded the opportunity to train medical doctors and nurses on a One Health approach to zoonotic disease surveillance, including ethical and technical aspects of human questionnaires and protocols for safe sampling, storage, and transport of clinical specimens for viral testing. In addition, PREDICT has strengthened cold chain systems for transportation and testing of samples at the Institut Pasteur du Cambodge (IPC) in Phnom Penh, PREDICT's partner laboratory for testing.

PREDICT invited in-service Royal Government of Cambodia laboratory staff from the National Animal Health and Production Research Institute (NAHPRI) and the National Institute of Public Health (NIPH) for advanced viral detection training using PREDICT viral family testing protocols at the IPC laboratory. The workshop increased capacity within Cambodian national laboratory network for detection of prioritiy zoonotoic diseases and other emerging threats, and encouraged collaboration and dialog between different disciplines. The aim is for some of the viral family protocols to be transferred to their National laboratories in the future. In addition, veterinary students from the Royal University of Agriculture and medical students from the University of Health Sciences are also being trained in the laboratory to strengthen detection capabilities of Cambodia's health workforce.

Expanding international partnerships, the IPC has shared their experience and transferred knowledge to partners labs in the neighboring Southeast Asia region, most recently by hosting laboratory staff from Myanmar's Livestock Breeding and Veterinary Department (LBDV) for hands-on training in viral detection techniques.

## Laboratory systems

PREDICT/Cambodia is led by the Institut Pasteur du Cambodge (IPC), which is testing animal and human samples and training staff from the National Animal Health and Production Research Institute (NAHPRI) and the National Institute of Public Health (NIPH). Wildlife and human samples are being tested for eight families / genera: Corona-, Filo-, Influenza-, Paramyxo-, Alpha-, Flavi-, Bunya-, Rhabdo-, Hanta- and Picornaviruses. Livestock samples are being tested for five priority families: Corona-, Influenza-, Paramyxo-, Flavi- and Filovirus.

### Implementing partners

UC Davis, Institut Pasteur du Cambodge (IPC)

### Contacts

**Country Coordinator:** Veasna Duong, IPC (dveasna@pasteur-kh.org)

**Global Points of Contact**: Tracey Goldstein (tgoldstein@ucdavis.edu) and Lucy Keatts (lkeattsconmed@gmail.com), UC Davis

FACES OF
# PREDICT

# VIBOL HUL

Vibol Hul is a Senior Research Technician with the Institut Pasteur du Cambodge (IPC). During PREDICT-1, he tested wildlife samples from Cambodia at the IPC lab and helped to train Laos National Veterinary Laboratory staff, while completing his Master's Degree in Science, Biodiversity and Conservation at the Royal University of Phnom Penh. Through PREDICT-2, Hul became the field coordinator in addition to continuing to his work on viral detection at IPC. Through this new role he has furthered his laboratory and management skills and worked with multiple stakeholders at high-risk interfaces for zoonotic disease transmission in Cambodia. PREDICT's practical field and lab-based training have allowed Vibol to develop expertise working safely with bats and rodents and to gain a deeper understanding of how to apply the One Health approach to surveillance for zoonotic disease threats. Because of these experiences, Hul is now pursuing an in-service PhD studying Nipah virus in Cambodian bats. Now an asset to Cambodia's One Health workforce, Vibol excels at passing on his knowledge and experience to current veterinary and medical students and in-service government partners who work side by side with the PREDICT team in Cambodia.

**Cambodia**

**2011**

- Joined PREDICT Cambodia
- Completed Master's at the Royal University of Phnom Penh
- Became field work coordinator for Cambodia
- Pursuing PhD studying the Nipah virus in bats

**2017**

# CHINA

USAID | PREDICT
FROM THE AMERICAN PEOPLE

## WORKFORCE DEVELOPMENT

| 29 | 7 | 18 |
|---|---|---|
| STAFF | STUDENTS | GOVERNMENT |

26 MALE | 21 FEMALE

## ONE HEALTH SURVEILLANCE

1,460

318

2,055 INDIVIDUALS
5,808 SPECIMENS

277

172 SURVEYS & INTERVIEWS

## LAB STRENGTHENING

**2,898** TESTS — WUHAN INSTITUTE OF VIROLOGY

**1,526** TESTS — GUANGDONG CDC

TRAINING → LIMITED TESTING → TESTING ALL TARGET VIRAL FAMILIES

## IMPACT

**47 trained** in One Health skills

**2,055 individuals sampled** (humans and animals)

**172 individuals interviewed** in behavioral risk investigations

**4,424 tests** for 6 viral families

**80 viruses** detected

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## VIRAL FINDINGS

| PREDICT-1 | PREDICT-2 |
|---|---|
| 46 NEW VIRUSES | 4 NEW VIRUSES |
| | 2 PREDICT-1 VIRUSES |
| 22 KNOWN VIRUSES | 6 KNOWN VIRUSES |

# PREDICT/China

## Success stories

### One Health in action: Concurrent wildlife and human surveillance

PREDICT/China partnered with two hospitals in Guangdong Province; First Affiliated Hospital of Shantou Medical School and Tungwah Hospital of Dongguan, to conduct syndromic surveillance of people with disease of unknown origin and high levels of contact with animals. These hospitals were selected due to significant patient traffic from surrounding communities containing wet markets, live poultry markets, high density livestock facilities, and small-scale farming with an abundance of rodents living in and around barns and homes. This year, PREDICT enrolled 218 syndromic patients, conducted in-depth questionnaires and collected 1,266 biological specimens for testing. Human surveillance was concurrent with sampling of bats and rodents that share space with the symptomatic population. In addition, PREDICT's partner laboratories completed over 1,500 tests of samples for five priority viral families.

In Yunnan Province, in coordination with the Forestry departments and local Chinese Centers for Disease Control (China CDC), PREDICT initiated human surveillance of communities living near bat caves in September 2017, concurrent with sampling of wildlife (bats and rodents) at crop production and market value chain interfaces. PREDICT's One Health approach to zoonotic disease surveillance by concurrently sampling hospital patients, communities, and wildlife interactions is contributing to our understanding of viral spillover in the region.

*PREDICT-trained Yunnan CDC personnel collecting biological samples from community participants. Photo credit: PREDICT/China*

### Workforce development

PREDICT hosted two in-service human surveillance training sessions in Guangzhou and Yunnan Provinces in October 2016 and September 2017, respectively. Members of the Guangdong Institute of Public Health (GDIPH), two PREDICT implementing hospitals, as well as local and provincial prefecture CDC representatives from Guangdong, Shantou, and Dongguan were trained to identify patients presenting with syndromes of interest, carry out the consent process, collect biological samples, and administer a behavioral risk questionnaire. In preparation for community human surveillance, PREDICT conducted a remote training session on ethical research and human sampling, followed by a local training event in Yunnan with members from the provincial and prefecture-level CDCs. In addition, core competency and booster trainings were provided to team members at Wuhan

Institute of Virology on laboratory biosafety and PPE in February, March, and May 2017.

Additionally, the Institute of Pathogen Biology, Chinese Academy of Medical Sciences and Peking Union Medical College requested a PREDICT training session for their field staff based in China and Africa on PPE use, biosafety, and safe animal sampling in February 2017. Thus, providing an opportunity to expand the workforce able to conduct zoonotic animal surveillance in China and beyond.

### Improving scientific knowledge and communication

PREDICT expertise and surveillance activities contributed to the following scientific publication on zoonotic disease in China "Genetically Diverse Filoviruses in Rousettus and Eonycteris spp. Bats, China, 2009 and 2015" in the journal *Emerging Infectious Diseases* providing further evidence that fruit bats are key reservoirs for filoviruses.

### Advocate for global collaborations on responses to emerging infectious diseases

PREDICT organized two workshops at the Institute of Microbiology of Chinese Academy of Sciences in Beijing on a global initiative to discover viruses in all animals, the *Global Virome Project*. The meetings bought together more than 100 experts from governmental, academic, and private sectors from the USA, UK, Norway, Australia, Denmark and China, to discuss and identify resources to support a global coordinated response effort to emerging infectious diseases.

In addition, PREDICT co-organized the *2nd China-U.S. Workshop on the Challenges of Emerging Infections, Laboratory Safety and Global Health Security* with the U.S. National Academy of Sciences. Bringing together health professionals and encouraging international relations, strengthened China-USA collaborations to proactively address global health security issues.

## Laboratory systems

PREDICT/China is partnering with Wuhan Institute of Virology of Chinese Academy of Sciences for wildlife and human testing, and Guangdong Institute of Public Health at Guangdong CDC for testing of specimens from hospital-based syndromic surveillance. Both labs are trained and are actively testing human and wildlife samples for five priority viral families (corona, filo, flavi, influenza, and paramyxo viruses). PREDICT has also engaged two new laboratories at the Institute of Microbiology of the Chinese Academy of Sciences and Yunnan Institute of Endemic Diseases Control and Prevention for future wildlife and human sample testing.

### Implementing partners

Wuhan Institute of Virology of Chinese Academy of Sciences, EcoHealth Alliance, Metabiota, Inc.

### Contacts

**Country Coordinator:** Zhengli Shi, Wuhan Institute of Virology, Chinese Academy of Sciences (zlshi@wh.iov.cn)

**Global Point of Contact**: Jon Epstein, EcoHealth Alliance (epstein@ecohealthalliance.org)

# INDIA

USAID FROM THE AMERICAN PEOPLE | PREDICT

Global Health Security Agenda

## WORKFORCE DEVELOPMENT

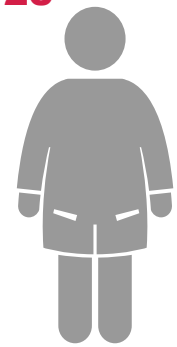
**11**
**STAFF**

6 MALE | 5 UNREPORTED

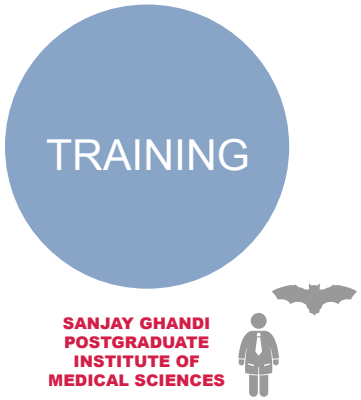
## ONE HEALTH SURVEILLANCE

**23**

**23** INDIVIDUALS
**389** SPECIMENS



## LAB STRENGTHENING




TRAINING → LIMITED TESTING → TESTING ALL TARGET VIRAL FAMILIES

## IMPACT

**11 trained** in One Health skills

**23 humans sampled**

**Training planned** for viral testing

www.predict.global

PREDICT/India and Bangladesh teams pose for a picture with an anesthetized macaque during a training on safe live-capture and sampling techniques held in Bangladesh. *Photo credit: PREDICT/Bangladesh*

# PREDICT/India

## Success stories

### Partnerships in support of the Global Health Security Agenda

PREDICT/India has been an active participant in the application and review of the Global Health Security Agenda (GHSA) in India. Participation at three key meetings, in November 2016, April and July 2017, facilitated communication and coordination of activities between PREDICT and key government and international stakeholders, including the US CDC India office and high-level officials from various departments within the Government of India's Ministry of Health and the Indian Medical Research Council. PREDICT emphasized its One Health approach to understanding zoonotic disease, outlined goals and implementation of concurrent wildlife and human surveillance, and conducted outreach to Government of India institutions from the human (National Institute of Virology, Indian Council of Medical Research (ICMR)) and animal (Indian Veterinary Research Institute, Indian Council of Agricultural Research (ICAR)) sectors, as well as Uttar Pradesh state health and wildlife agencies. By building partnerships across human and animal sectors, PREDICT contributes to GHSA objectives to increase capacity to detect zoonotic viruses that may threaten public health in India.

### Strengthening South Asia's One Health Network

In March 2017, members of PREDICT/India's field and laboratory teams attended a regional workshop entitled

*Participants at the Zoonotic Disease Pandemic Preparedness for South Asia, Using One Health Platform workshop in Nepal. Photo credit: PREDICT/Nepal.*

*Zoonotic Disease Pandemic Preparedness for South Asia, Using One Health Platform* in Kathmandu, Nepal, organized by

PREDICT/Nepal. There, the PREDICT/India team was able to build upon the existing expertise of the PREDICT/Bangladesh and Nepal, as well as experts from Bhutan. At the workshop, participants presented updates on the status of One Health platforms and activities in the South Asia region, shared information on ways to prevent the spread of infectious diseases between animals and people, and identified roles and responsibilities for effective multi-sectoral communication and coordination during outbreaks, especially transboundary disease events. The workshop also served to highlight gaps in current zoonotic disease surveillance and outbreak preparedness and response programs. PREDICT/India presented progress to date, and together with PREDICT/Bangladesh, participated in a round table discussion on implementing One Health projects.

### Building capacity and developing partnerships for One Health surveillance

As part of PREDICT's regional approach to capacity strengthening and developing One Health networks among

active professionals, the PREDICT/India team trained with project partners in Nepal and Bangladesh, enhancing regional coordination and building skills and competencies for zoonotic

disease surveillance. In March, the PREDICT/India Field Coordinator travelled to Dhaka, Bangladesh, where in a unique bilateral training opportunity, the two PREDICT teams shared experience and expertise on the live-capture and safe sampling of Rhesus Macaque monkeys, bats and rodents. The similar environment and species diversity between Bangladesh and Uttar Pradesh, Northern India provides continued opportunities for the two countries to communicate and exchange best practices, and for PREDICT to collect data across an expansive 'eco-epizone' within the Gangetic Plain.

PREDICT has identified two field sites for concurrent sampling in Maharajganj District, Uttar Pradesh, Northern India. Following consultation and assessment with local and government stakeholders, these sites were considered a high-risk area for zoonotic disease spillover and transmission due to; a high incidence of Acute Encephalitis Syndrome, mostly of unknown etiology; a high degree of human-animal interaction, a porous international border with Nepal to the North and close proximity to Bangladesh's border to the East. This year, all ethical clearances and administrative approvals were obtained, allowing for human and animal surveillance activities to begin.

As part of initial field activities, two governmental clinics, Nichlaul Community Health Centre (CHC) and Partawal CHC, were enrolled for hospital-based syndromic surveillance, and corresponding operational points of contact identified for training on PREDICT human surveillance protocols. Outreach and sensitization for PREDICT concurrent wildlife and human surveillance activities in nearby communities has been initiated, and PREDICT plans to begin community-based human and wildlife surveillance, as well as hospital-based, syndromic surveillance next year.

## Laboratory systems

PREDICT/India is partnering with the Sanjay Gandhi Postgraduate Institute of Medical Sciences (SGPGIMS) as its implementing partner for human and animal surveillance. PREDICT has transferred laboratory protocols to SGPGIMS, and they are prepared to implement viral family testing for priority zoonotic diseases and other emerging threats across five viral families. Initial laboratory testing standardizations have been initiated, and lab staff have been trained on PREDICT protocols, including cold chain, diagnostic testing, and laboratory safety.

### Implementing partners

EcoHealth Alliance; Sanjay Gandhi Postgraduate Institute of Medical Sciences (SGPGIMS)

### Contacts

**Country Coordinator:** Dr. Rajesh Bhatia, EcoHealth Alliance, Delhi (Drrajesh.bhatia1953@gmail.com)

**PREDICT/India Principal Investigator:** Dr. Tapan N. Dhole, Sanjay Gandhi Postgraduate Institute of Medical Sciences, SGPGIMS (tndhole@gmail.com)

**Global Point of Contact**: Jon Epstein, EcoHealth Alliance (epstein@ecohealthalliance.org)

# INDONESIA

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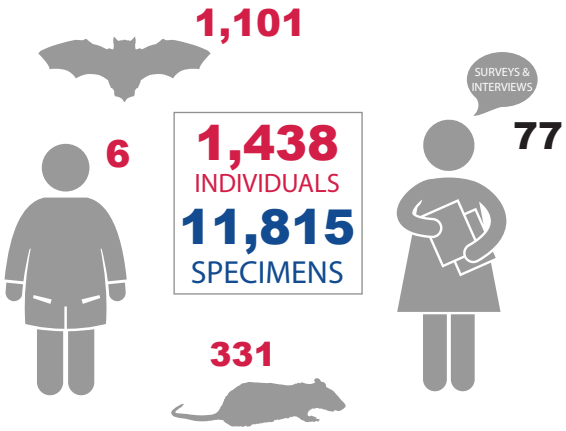
Global Health Security Agenda

## WORKFORCE DEVELOPMENT

| 21 | 1 | 19 | 8 |
|---|---|---|---|
| STAFF | STUDENTS | GOVERNMENT | OTHER |

27 MALE | 22 FEMALE

## ONE HEALTH SURVEILLANCE




## LAB STRENGTHENING

TESTS NOT YET CONDUCTED

10,004 TESTS

EIJKMAN INSTITUTE FOR MOLECULAR BIOLOGY (EIMB)

PRIMATE RESEARCH CENTER BOGOR AGRICULTURAL UNIVERSITY

TRAINING → LIMITED TESTING → TESTING ALL TARGET VIRAL FAMILIES

## IMPACT

- **49 trained** in One Health skills
- **1,438 individuals sampled** (humans and animals)
- **77 individuals interviewed** in behavioral risk investigations
- **10,004 tests** for 5 viral families
- **32 viruses** detected

www.predict.global

## VIRAL FINDINGS

| PREDICT-1 | PREDICT-2 |
|---|---|
| 14 NEW VIRUSES | 5 NEW VIRUSES |
| 6 KNOWN VIRUSES | 4 PREDICT-1 VIRUSES |
| | 3 KNOWN VIRUSES |

# PREDICT/Indonesia

## Success stories

### Strengthening national laboratory systems

PREDICT/Indonesia completed training Animal Disease Investigation Center (DIC) laboratory staff on the detection of known and emerging viral threats. Two sessions were held with laboratory professionals from the DICs of Subang-West Java, and Bukittinggi-West Sumatra on how to train other laboratory leads ("Training of the Trainers") in the use of PREDICT protocols, and how to interpret results. The workshops equipped trainees with the bench skills required for running viral detection tests and the knowledge to interpret them.

With continued technical assistance from PREDICT and PRC-IPB and support from FAO-ECTAD Indonesia, all eight DICs spanning Indonesia (Subang, Bukittinggi, Maros, Wates, Lampung, Banjarbaru, Denpasar, and Medan), will now have the capability to implement PREDICT viral family detection protocols and conduct routine testing of animal specimens for improved zoonotic disease surveillance. Moving forward, the DIC at Maros will conduct PREDICT viral family testing for domestic animal samples collected concurrently with wildlife from the Island of Sulawesi.

### Building partnerships for human health

PREDICT is currently coordinating with local hospitals, primary health care centers, community leaders, as well as universities to implement human behavioral surveillance and to conduct syndromic and community surveillance for zoonotic spillover. This coordination has involved several scoping visits to sensitize target communities in Sulawesi, training events with hospital staff and other personnel, and other meetings for partner engagement.

*Participants gather while attending the "Uncovering Zoonotic and Emerging Viruses in Indonesia" workshop on May 15-17, 2017 at the Eijkman Institute for Molecular Biology in Jakarta. Photo credit: PREDICT/Indonesia.*

### Promoting the integration of conservation and public health

This year, PREDICT participated in two seminars promoting cross-disciplinary approaches to animal health and zoonotic disease in Indonesia. In collaboration with the Primate Research Center at Bogor Agricultural University and the Indonesian Wildlife, Aquatic, and Exotic Animal Veterinarian Association, PREDICT held a one-day national seminar addressing current issues in conservation medicine of Indonesian non-human primates and other wildlife to Support Human and Animal Welfare Practices". Approximately 130 participants took part in the seminar, including; veterinarians, biologists, conservationists, and researchers from government and private sector from across Indonesia.

In addition, PREDICT conducted a Virology Seminar and Workshop at the Eijkman Institute for Molecular Biology. The events improved the capacity of participants to identify and characterize emerging zoonotic viruses as an effort to strengthen Indonesia's diagnosis capability, particularly within the human health sector. The seminar was attended by 65 participants (49 women; 16 men), from various disciplines, including clinicians, laboratory technicians and biomedical researchers from the Centre for Environmental Health and Disease Control (BBTKL), Centre for Health Laboratory (BLK), Zoonosis Sub Directorate Ministry of Health, and University medical faculties. The workshop provided the opportunity for participants to learn about biosafety, molecular virus detection, and bioinformatics data analysis.

### SEAOHUN Fellowship Program

PREDICT welcomed Ms. Tengku Idzan Nadzirah from the Department of Parasitology Molecular Laboratory, Faculty of Medicine, University of Malaya, Kuala Lumpur for a fellowship program in collaboration with SEAOHUN (South-East Asia One Health University Network), from September 11 to December 11, 2017. Ms. Tengku Idzzan has been working at the PRC-IPB and EIMB labs to gain hands-on experience in laboratory assays for zoonotic disease detection. The objectives of the fellowship are to provide professionals with practical, trans-disciplinary experience in One Health projects, and to encourage them to integrate and apply One Health experience and knowledge into their professional practice.

## Laboratory systems

PREDICT/Indonesia is partnering with; the Primate Research Center of the Institut Pertanian Bogor (PRC-IPB) at Bogor Agricultural University, that is implementing viral testing of samples collected from wildlife for priority viral families to detect priority zoonotic diseases, and the Eijkman Institute for Molecular Biology (EIMB), that will be implementing human surveillance and human specimen testing.

### Implementing partners

EcoHealth Alliance (EHA), Metabiota (MB), Primate Research Center of the Institut Pertanian Bogor (PRC-IPB) at Bogor Agricultural University, and the Eijkman Institute for Molecular Biology (EIMB).

### Contacts

**Country Coordinator:** Dr. Joko Pamungkas, PRC-IPB (jpi-pssp@indo.net.id)

**Global Point of Contact**: Kevin Olival, EHA (olival@ecohealthalliance.org)

# LAO PDR

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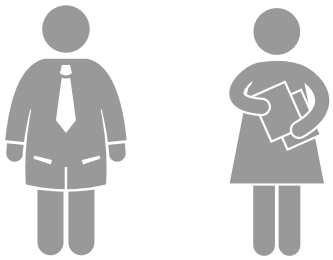
Global Health Security Agenda

## WORKFORCE DEVELOPMENT

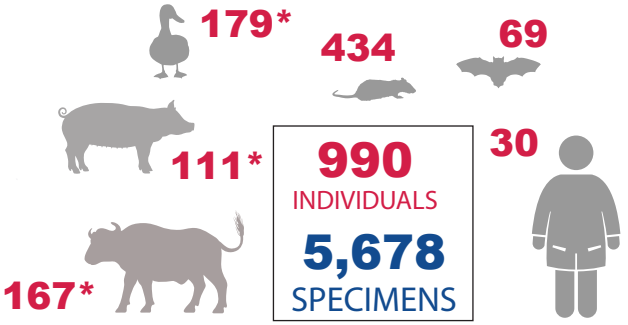
**28** STAFF

**18** GOVERNMENT



18 MALE | 15 FEMALE

## ONE HEALTH SURVEILLANCE




*Samples collected in collaboration with FAO

## LAB STRENGTHENING

TRAINING → LIMITED TESTING → TESTING ALL TARGET VIRAL FAMILIES

## IMPACT

**33 trained** in One Health skills

**990 individuals sampled** (humans and animals)

**5,435 tests** for 5 viral families

**21 virueses** detected

www.predict.global

## VIRAL FINDINGS

**16** NEW VIRUSES

**5** KNOWN VIRUSES

**PREDICT-1**

# PREDICT/Lao PDR

## Success stories

### From partnerships to practice: concurrent One Health surveillance

PREDICT/Lao PDR developed a One Health framework, through partnerships with the Government of Lao PDR, District and Provincial Agriculture and Forestry Offices, the National Animal Health Laboratory (NAHL), the National Center for Laboratory and Epidemiology (NCLE), and Food and Agriculture Organization of the United Nations (FAO), in which to conduct concurrent longitudinal surveillance of wildlife, livestock and humans at interfaces identified as high-risk for zoonotic transmission. PREDICT has created a strong foundation in-country for successful coordination of partner efforts, and as a result PREDICT and FAO coordinated four animal surveillance trips to Champasak Province, holding joint community engagement meetings and collecting concurrent wildlife and livestock samples in Na Pa Kieb village, Khong District.

In Na Pa Kieb village, two priority animal-human interfaces were identified and targeted for surveillance activities. Samples were collected along the animal value chain of hunted rodents. Rodents (squirrels, giant flying squirrels, Asian red-cheeked squirrel, etc) hunted in the forest surrounding the village are either locally consumed, or sold to middlemen who then take the animals to a market for trade. Capturing alternative potential zoonotic virus transmission routes, samples were also obtained from peri-domestic rodents living in close quarters with household occupants, and among long-term rice storage areas. In addition, bats in and around Na Pa Kieb village were targeted for surveillance.

*Community members gather at the village temple in Na Pa Kieb village to learn about and discuss human sampling activities with PREDICT Lao PDR. Photo credit: David McIver, PREDICT*

By working together on field-based activities and through of sharing data, cross-disciplinary partnerships have been formed, as has the core technical capacity of Lao's institutions and workforce for biological sampling, surveillance and epidemiological analysis between populations. Thus, strengthening the countries capabilities for zoonotic disease detection, preparedness and response.

### One Health capacity strengthening in the Human sector

PREDICT invited 15 representatives from national, provincial, district and community levels to an interactive learning laboratory on human syndromic surveillance in a One Health context. In addition to thoroughly engaging and preparing individuals to implement PREDICT human syndromic surveillance protocols, this training served as an opportunity for cross-organizational dialogue about zoonotic disease surveillance in Lao, between NCLE, Champasak Provincial

Health Office, Khong District Health Office, Khong District Hospital, the Soth Village Healthcare Center, and Na Pa Kieb village. PREDICT conducted two days of classroom professional development, providing an overview of PREDICT's One Health approach to zoonotic surveillance, and training on specific protocols, enrolment parameters, ethical considerations in human subjects research, biosafety and security, and best practices. Following this, two days were spent refining field skills in Na Pa Kieb village, where PREDICT wildlife and livestock surveillance has been ongoing since May 2016.

Engagement of the community through participatory dialog in village meetings built enthusiasm and support to conduct human surveillance activities. PREDICT closely supervised course participants as they enrolled 30 community members, focusing on individuals who interact frequently with wildlife and livestock. Putting protocols into practice, the health professionals were guided through the process of obtaining informed consent, conducting questionnaires on human demographics and behaviour, and the safe collection, storage and transport of biological samples. This field-based experience served to convey essential knowledge and strengthen skillsets for human syndromic surveillance at provincial and district levels, as well as provided an opportunity for open communication between government organizations, health facilities, and community members in Na Pa Kieb village.

## Laboratory systems

PREDICT/Lao PDR is partnering with the National Animal Health Laboratory, Department of Livestock and Fisheries, Ministry of Agriculture and Forestry (NAHL), which is actively testing samples for five viral families (corona-, filo-, flavi-, influenza-, and paramyxoviruses). Human specimen testing for five viral families (corona-, filo-, flavi-, influenza-, and paramyxoviruses) will take place at the National Center for Laboratory and Epidemiology (NCLE), Department of Communicable Disease Control, Ministry of Health.

### Implementing partners

Metabiota, Inc., National Animal Health Laboratory (NAHL), and the National Center for Laboratory and Epidemiology (NCLE).

### Contacts

**Country Coordinator:** Soubanh Silithammavong, Metabiota, Inc. (ssilithammavong@metabiota.com)

**Global Point of Contact**: David McIver, Metabiota, Inc. (dmciver@metabiota.com)

# MALAYSIA

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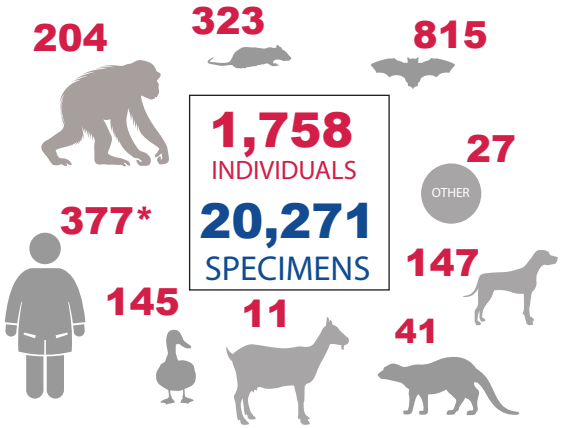
Global Health Security Agenda

## WORKFORCE DEVELOPMENT

| 116 | 19 | 190 |
|---|---|---|
| STAFF | STUDENTS | GOVERNMENT |

182 MALE | 114 FEMALE

## ONE HEALTH SURVEILLANCE




*Samples collected in collaboration with the Malaysian government

## LAB STRENGTHENING

| 8,546 TESTS | 4,366 TESTS | 2,429 TESTS |
|---|---|---|
| WILDLIFE HEALTH, GENETIC AND FORESNSIC LABORATORY, SABAH WILDLIFE DEPARTMENT | VIROLOGY LAB, FACULTY OF VETERINARY MEDICINE, UNIVERSITY PUTRA MALAYSIA | PERHILITAN WILDLIFE FORENSIC LABORATORY |

TRAINING | LIMITED TESTING | TESTING ALL TARGET VIRAL FAMILIES

## IMPACT

**296 trained** in One Health skills

**782 individuals sampled** (humans and animals)

**15,341 tests** for 8 viral families

**81 viruses** detected

www.predict.global

## VIRAL FINDINGS

| PREDICT-1 | PREDICT-2 |
|---|---|
| 57 NEW VIRUSES | 4 NEW VIRUSES |
| 19 KNOWN VIRUSES | 1 KNOWN VIRUSES |

## PREDICT/Malaysia

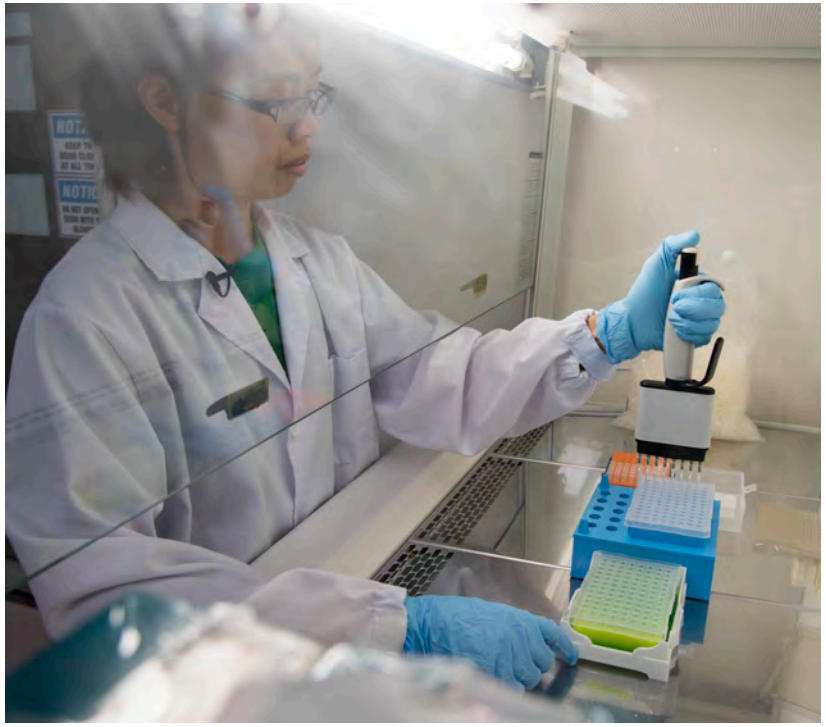
## Success stories

### Strengthening biosecurity, the workforce, and disease detection capability in the national laboratory system

Through PREDICT's efforts to train and strengthen laboratory safety and capacity for improved disease detection, the Malaysian laboratory network has made gains in advancing its laboratories to international standards. In March 2017, the molecular zoonosis laboratories at the Department of Wildlife and National Parks, PERHILITAN, a PREDICT partner, were certified as BSL-2 laboratories according to the United States' standards for laboratory specifications. In addition, the PREDICT/Malaysia laboratory manager attended the Asia-Pacific Biosafety Association's biosafety training and passed the biosafety management test, a major capability gain for the country's laboratory system.

In another achievement, the Sabah Wildlife Department (SWD) Wildlife Health, Genetic and Forensic Laboratory passed its annual BSL2 Certification for the third year in a row, a result of PREDICT collaboration with local government, with accolades for the standards SWD and PREDICT have maintained.

Finally, by strengthening interagency coordination for improved impact on national surveillance systems, PREDICT with support from the Defence Threat Reduction Agency Cooperative Biological Engagement Program (DTRA-CBEP), transferred a multiplex serology assay to Government of Malaysia partner labs at PERHLIITAN and the Ministry of Health's National Public Health Laboratory, as part of a joint project to screen wildlife, livestock, and people for antibodies



*PREDICT/Malaysia's lab manager Mei Ho Lee pipettes inside a biosafety cabinet. Mei Ho Lee is now certified for biosafety management and is contributing to improved biosafety practices in Malaysia's laboratory system. Photo: Jonathan Goley/EHA.*

against henipaviruses and filoviruses. The PREDICT team and its project partners from Uniformed Services University trained nine staff from PERHLITAN and NPHL to use the Bioplex serology machine in a one-week training session. PREDICT wildlife samples were tested as part of the training, and participants learned to interpret serology outputs in the context of unknown viruses. This collaboration between PREDICT and DTRA substantially strengthens the capabilities within the wildlife and human health sectors in Malaysia to conduct surveillance for high consequence zoonotic pathogens. The

project will screen PREDICT samples from Orang Asli communities over the next three years to determine whether henipa- and filoviruses are spilling over from bats in Malaysia.

Finally, PREDICT continued to enhance the laboratory workforce in Malaysia by training numerous staff from multiple government and university partners on PREDICT laboratory procedures and protocols at the National Public Health Laboratory, PERHILITAN, and the Universiti Putra Malaysia (UPM).

## Community-based One Health surveillance

PREDICT/Malaysia has been working closely with the Ministry of Health and Peninsular Malaysia (PERHILITAN) National Wildlife Forensic Laboratory to conduct coordinated surveillance in Orang Asli villages where livestock are raised and wildlife hunting occurs for subsistence. These villages are considered a potential high-risk interface where people, livestock and wildlife have frequent contact. PREDICT's One Health surveillance teams have collected biological samples from wildlife, domestic animals, and people (the human surveillance effort initiated by EcoHealth Alliance in partnership with the Government of Malaysia and in parallel with PREDICT) who have frequent contact with animals, as well as behavioral data to help characterize risk of spillover. The samples are being screened for targeted viral families at partner laboratories.

In addition, PREDICT contributed to the education of the future One Health workforce by training students on PREDICT laboratory protocols and biosafety best practices from multiple education facilities, including students from UPM, Management and Science University, PERHILTON, and UCSI University. Finally, in July 2017, PREDICT lead a training event at the National Public Health Lab, which included

*PREDICT/Malaysia's leads a Community Meeting at Pos Lenjang, Kuala Lipis in April 2017. PREDICT provided an introduction to activities and education on zoonotic viruses and animal safety. Photo credit: T. Hughes, EcoHealth Alliance.*

seminars on viral discovery and viral discovery as a tool in pandemic preparedness; tutorials on consensus PCR as a tool for viral discovery and phylogenetic analysis; and a practical on designing PCR primers and building phylogenetic trees.

## Developing field surveillance capacity

Improving the countries capacity to conduct zoonotic disease surveillance and advancing collaboration with USAID's One Health Workforce in Malaysia, PREDICT taught core skills through lectures and practical exercises in: safe sampling techniques, PPE use, biosafety, and sample storage in lab and field settings to a range of health professionals and students (veterinarians, research officers, wildlife rangers/enforcers) at

the Wildlife Rescue Unit in Sabah, PERHILITAN, and UPM Faculty of Veterinary Medicine (FVM).

### Sharing knowledge to improve viral surveillance

In December 2016, the PREDICT lab and field managers presented posters on PREDICT/Malaysia's wildlife surveillance work at the 4th International One Health Congress & The 6th Biennial Conference of the International Association for Ecology and Health (OHEH 2016) congress in Melbourne, Australia. Their presentations were entitled "Assessing Viral Diversity in Non-human Primates and Bats of Peninsular and Bornean Malaysia" and "Zoonotic Viruses Surveillance for the Confiscated Pangolin in Malaysia." In addition, PREDICT contributed to a presentation given by the Director of Disease Control Division at GHSA meeting "Enhancing Joint Collaborative Efforts for Lab Preparedness" February 8-10, 2017, in Bangkok, Thailand.

### Policy change to improve occupational health

As a result of PREDICT's capacity strengthening efforts and engagement with Government of Malaysia's partners, for the first time, the Ministry of Natural Resources and Environment (MNRE) provided funding for vaccinations of 100 PERHILITAN Research Officers and Rangers. PREDICT was invited to advise on this process, a major step toward reducing occupational health hazards for people working on the front lines of high-risk human-animal interfaces.

## Laboratory systems

PREDICT/Malaysia partners with the PERHILITAN National Wildlife Forensic Laboratory and the Sabah Wildlife Department Wildlife Health and Genetic and Forensic Laboratory for wildlife sample testing. Both labs are actively testing samples for five priority viral families. The Universiti Putra Malaysia (UPM) Faculty of Veterinary Medicine is the laboratory partner for livestock testing and is currently in training. The National Public Health Laboratory Peninsular Malaysia and National Public Health Laboratory Sabah are the laboratories for human testing: NPHL Peninsular Malaysia is implementing viral testing, while NHPL Sabah is in training. NPHL Peninsular Malaysia is continuing to use PREDICT viral family testing techniques for its own disease investigations.

### Implementing partners

EcoHealth Alliance, Conservation Medicine, Ltd., PERHILITAN and the National Wildlife Forensic Laboratory, Sabah Wildlife Department Wildlife Health and Genetic and Forensic Laboratory, University of Peninsular Malaysia, the National Public Health Laboratory Peninsular Malaysia, and the National Public Health Laboratory Sabah, Ministry of Health and its District Health teams, Department of Veterinary Services, Universiti Putra Malaysia Faculty of Veterinary Medicine, Sabah Wildlife Department and the Wildlife Health and Genetic and Forensic Laboratory, Danau Girang Field Centre, Universiti Malaysia Sabah, Sabah State Health Department, Queen Elizabeth Hospital, and the Kota Kinabalu Public Health Laboratory in Sabah.

### Contacts

**Country Coordinator:** Tom Hughes, EHA (tom.hughes@ecohealthalliance.org)

**Global Point of Contact**: Jon Epstein, EHA (epstein@ecohealthalliance.org)

# MONGOLIA

USAID | PREDICT
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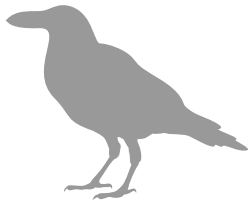
## WORKFORCE DEVELOPMENT

| 8 | 60 | 8 |
|---|---|---|
| STAFF | GOVERNMENT | OTHER |

51 MALE | 25 FEMALE

## ONE HEALTH SURVEILLANCE

2,268



**2,268** INDIVIDUALS

**4,660** SPECIMENS

## LAB STRENGTHENING

**2,600** TESTS

STATE CENTRAL VETERINARY LABORATORY

TRAINING → LIMITED TESTING → TESTING ALL TARGET VIRAL FAMILIES

## IMPACT

**76 trained** in One Health skills

**2,268 wild birds sampled**

**2,600 tests** for influenza viruses

**1 virus** detected

www.predict.global

## VIRAL FINDINGS

**1**
KNOWN VIRUS

**PREDICT-2**

# PREDICT/Mongolia

## Success Stories

### Wild bird surveillance and training for highly pathogenic avian influenza

This year, PREDICT/Mongolia conducted avian influenza surveillance at 14 sites in Mongolia. Sites visited included the historic H5N1 outbreak sites at Erkhel Lake, Khunt Lake, Sharga Lake, and the Tes River Delta near Uvs Lake where Russian authorities detected H5N8 highly pathogenic avian influenza of clade 2.3.4.4 in wild birds along the Russia-Mongolia border in June 2016. During surveys, fecal samples were collected from live birds and post mortem examination was conducted on dead birds that were encountered. Field surveillance focused on wild water bird species at risk of influenza infection including swans, ducks, geese and shelducks. A total of 19 local experts, including 13 veterinarians from six provincial veterinary laboratories, three protected area rangers, and three provincial zoonotic diseases experts, were engaged in PREDICT field surveillance activities, through which they were trained in surveillance strategies and safe practices.

### Surveillance activities at Uvs Lake

Two weeks of intensive surveillance was conducted along the eastern shore of Uvs Lake from June 5-20, 2017. Avian influenza in wild birds has previously been identified on the Russian side of Uvs Lake, within the Tuva Republic, in 2006, 2015, and 2016. PREDICT surveillance along the Mongolian side of the lake was conducted to investigate any possible signs of avian influenza outbreaks in wild water birds in the region. Surveillance included collection of guano samples and

*A trained field technician collects guano samples for avian influenza surveillance at Ugii Lake, Mongolia, May-13-2017. Photo credit: @Ulaankhuu/SCVL*

shoreline transect surveys to detect sick and dead birds. Guano samples were collected from wild water birds at two sites in Uvs Lake, including the Tes River Delta and Jiraag River Delta. Additionally, tissue samples were collected from dead seabirds at the Jiraag River Delta and at Baga Lake.

### Strengthening disease detection capability in the national laboratory system

PREDICT partnered with Wildlife Conservation Society (WCS) pathologists from the Bronx Zoo Pathology Department to conduct capacity building for Mongolian State Central Veterinary Laboratory (SCVL) virologists who have annually participated in avian influenza field surveillance activities. In total, six virologists from SCVL, and two PREDICT/Mongolia staff were trained on full avian necropsy, PPE and biosafety,

*A technician tests samples for known and emerging viruses using PREDICT-2 protocol at the State Central Veterinary Laboratory Oct 15, 2017. Photo credit: SCVL/Ulaankhuu*

sample collection, and cold chain techniques for sample transfer and shipment. The PREDICT partner laboratory at SCVL, has been trained to conduct molecular detection of avian influenza viruses using PREDICT protocols and has successfully performed over 2,500 tests for avian influenza. PREDICT established a communication network for the Government of Mongolia to receive and review PREDICT laboratory results. The first batch of PREDICT results for public release are being prepared for ministry approval.

## Laboratory systems

PREDICT is partnering with the Mongolian State Central Veterinary Laboratory (SCVL), which is actively testing for influenza viruses with the potential to expand to additional viral families. The National Influenza Center (NIC) at the Mongolian National Center for Communicable Diseases (NCCD) has also received PREDICT protocols through an existing link between NCCD and SCVL.

### Implementing partners

Wildlife Conservation Society (WCS), Mongolian State Central Veterinary Laboratory (SCVL)

### Contacts

**Country Coordinator:** Enkhtuvshin Shiilegdamba, WCS (eshiilegdamba@wcs.org)

**Global Point of Contact**: Amanda Fine, WCS (afine@wcs.org)

# MYANMAR

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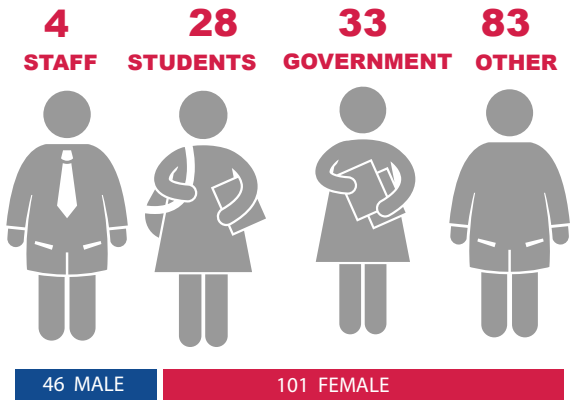
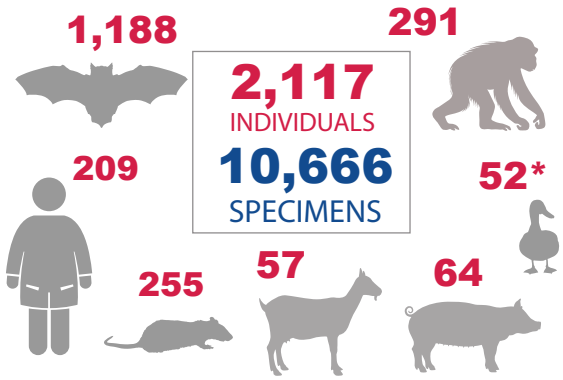
## WORKFORCE DEVELOPMENT

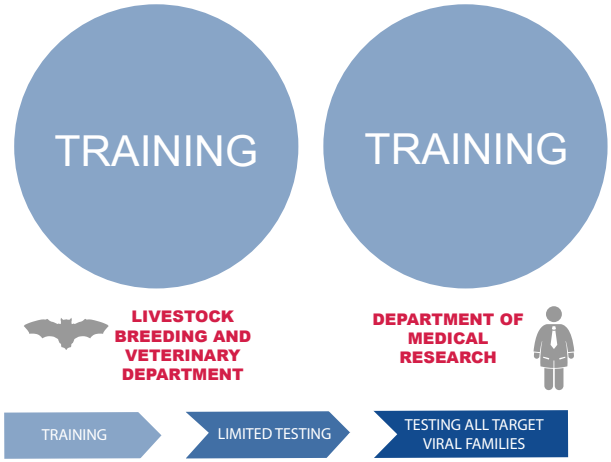


## ONE HEALTH SURVEILLANCE




*Samples collected in collaboration with FAO

## LAB STRENGTHENING




Samples were tested at UC Davis during training of DMR lab technicians. 1,085 tests were conducted at UC Davis across 5 viral families as part of the training.

## IMPACT

**148 trained** in One Health skills

**2,117 individuals sampled** (wildlife and domestic animals)

**Training planned** for viral testing

**2 viruses** detected

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## VIRAL FINDINGS

**1**
NEW VIRUS

**1**
PREDICT-1 VIRUS

**PREDICT-2**

# PREDICT/Myanmar

## Success Stories

### Leading risk-based One Health surveillance

Through key partnerships, training, and field-based zoonotic disease surveillance activities, PREDICT is building the foundation for applying the One Health approach in Myanmar, including strengthening lab systems and advancing viral detection capability. Risk-based wildlife & livestock surveillance was successfully conducted at the Hpa-an caves of Kayin State and areas surrounding Hlawga National Park of Northern Yangon, where teams collected nearly 9,000 samples from over 1,000 individual animals. The PREDICT team works closely with FAO, having trained representatives on biosafety, surveillance, and sampling protocols and data management for livestock surveillance activities.

Concurrent with animal sampling, human zoonotic disease surveillance commenced this year at these same locations where high-risk animal-human interfaces were identified. Volunteer assistants from the Ministry of Health & Sports (MOHS) conducted quantitative behavioral risk interviews paired with biological sample collection from community members, with over 2,000 samples collected from over 200 individuals this year.

Finally, to support sustainability of zoonotic disease surveillance, PREDICT developed local supply chains for field and laboratory supplies from private Yangon-based small businesses, contributing to the local economy and linking our partner institutions with suitable vendors.

*A PREDICT/Myanmar team member talks with a key informant at the Hpa-An site where the team is collecting samples from animals and people as part of One Health disease surveillance activities. Photo: Marc Valitutto, PREDICT/Myanmar.*

## Building collaborative multi-sectoral partnerships

PREDICT is positioned as an instrumental partner in the Ministry of Health & Sports (MOHS) mission to prioritize One Health implementation and zoonotic disease prevention, detection, and response throughout Myanmar. In addition to working together with key partners including the US Centers for Disease Control, World Health Organization (WHO), and Food and Agriculture Organization (FAO), other ministries including the Ministry of Livestock, Agriculture, & Irrigation (MOLAI) and Ministry of Natural Resources & Environmental Conservation (MONREC) have been encouraged to join One Health discussions, largely due to the collaborative work performed during PREDICT surveillance activities.

Representatives from the three Government of Myanmar ministries (MOHS, MOLAI, MONREC) have taken an active role in in PREDICT field surveillance and have been instrumental in community engagement. PREDICT provided comprehensive training and education, including a lecture series to all participants, expanding the number of individuals in the Government of Myanmar's workforce that are capable of safely conducting zoonotic disease activities. Finally, PREDICT provided technical expertise to national outbreak preparedness and response efforts by joining discussion panels for an avian influenza outbreak this past year.

# Laboratory Systems

PREDICT is partnering with the Department of Medical Research of the Ministry of Health & Sports (DMR) for human specimen testing, and the Livestock Breeding and Veterinary Department Laboratory of the Ministry of Livestock, Agriculture & Irrigation (LBVD) for wildlife and livestock testing. Scientists from both laboratories have received training in molecular techniques for viral detection. Infrastructure at both laboratories has also been strengthened to enable testing for zoonotic diseases from five targeted viral families (paramyxo-, corona-, filo-, and influenza viruses). Samples are being tested at PREDICT's global reference lab at the University of California, Davis One Health Institute while in country labs are preparing to begin testing.

## Implementing partners

Smithsonian Institution, Department of Medical Research (DMR) of the Ministry of Health & Sports (MOHS), the Livestock Breeding and Veterinary Department (LBVD) Laboratory of the Ministry of Livestock, Agriculture & Irrigation (MOLAI), and the Ministry of Natural Resources & Environmental Conservation (MONREC).

## Contacts

**Country Coordinator:** Dr. Ohnmar Aung, Smithsonian Institution (ohnmara@gmail.com)

**Global Point of Contact**: Dr. Marc Valitutto, Smithsonian Institution (valituttom@si.edu)

# NEPAL

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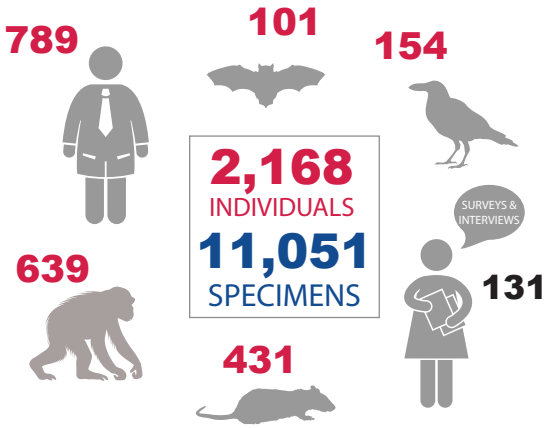
FROM THE AMERICAN PEOPLE

## WORKFORCE DEVELOPMENT

| 29 | 4 | 3 |
|---|---|---|
| STAFF | GOVERNMENT | OTHER |

24 MALE | 12 FEMALE

## ONE HEALTH SURVEILLANCE




## LAB STRENGTHENING

**10,788 TESTS**

CENTER FOR MOLECULAR DYNAMICS NEPAL / INTREPID NEPAL

TRAINING → LIMITED TESTING → TESTING ALL TARGET VIRAL FAMILIES

## IMPACT

- **36 trained** in One Health skills
- **2,168 individuals sampled** (humans and animals)
- **131 individuals interviewed** in behavioral risk investigations
- **10,788 tests** for 5 viral families
- **17 viruses** detected

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## VIRAL FINDINGS

| PREDICT-1 | PREDICT-2 |
|---|---|
| 6 NEW VIRUSES | 1 NEW VIRUS |
| 5 KNOWN VIRUSES | 5 KNOWN VIRUSES |

# PREDICT/Nepal

## Success stories

### Rapid detection of H5N8 during an Influenza outbreak

PREDICT/Nepal is working to strengthen One Health platforms through collaborative efforts, multi-sectorial partnerships, and coordination in advance of disease outbreaks. PREDICT provided technical support to ministry partners during the March 2017 H5N8 influenza virus outbreak in Nepal. During the outbreak, approximately 3650 birds died, and authorities implemented culling of susceptible birds, with heightened surveillance to contain the spread of the disease in the affected area. Working together with the Nepal Central Veterinary Laboratory (CVL) and the national laboratory network, the PREDICT team at the Center for Molecular Dynamics, Nepal (CMDN) shared expertise and test protocols, facilitating the rapid identification and subtype characterization of the virus attributed as the cause of the outbreak.

### Regional workshop on zoonotic disease pandemic preparedness for South Asia

In partnership with the Regional Environment, Science, Technology, and Health (ESTH) Office for South Asia, PREDICT organized a workshop on 'Zoonotic Disease Pandemic Preparedness for South Asia Using a One Health Platform'. The event brought together over 80 people from government and non-government stakeholders in the animal, human, and environmental health sectors across South Asia, including participants from Bhutan, Bangladesh, India, Nepal, as well as the US, and regional representatives from FAO, WHO, and the CDC. PREDICT was showcased as a

*International participants at the 2017 Workshop on Pandemic Preparedness Using One Health Approach in South Asia. Photo credit: PREDICT/Nepal.*

successful approach of One Health surveillance, with activities designed to strengthen local capacity in characterization of zoonotic disease risks, and preparation for rapid response to zoonotic disease outbreaks. As such, PREDICT shared best practices for emerging zoonotic diseases surveillance, the One Health approach to outbreak investigations, and pandemic preparedness. As a result, the meeting strengthened national and regional capacity for zoonotic disease surveillance and research, and encouraged multi-disciplinary collaborations to expand One Health practices in the region.

### Concurrent wildlife and human surveillance

PREDICT established Nepal's first hospital-based zoonotic disease surveillance program in two hospitals: Chitwan Medical College (CMC) and Patan Academy of Health Science (PAHS). PREDICT provided zoonotic surveillance training to 10 staff working in the clinics. This effort aims to detect high-priority zoonotic viruses among syndromic patients who have regular interactions with animals. Combined with sampling of

*A local pilgrim feeding macaques at Swayambhunath Temple. Photo credit PREDICT/Nepal.*

wildlife at high-risk interfaces within the clinic catchment areas, these surveillance efforts aim to detect zoonotic viral pathogens and characterize ecological, biological, and behavioral risk factors associated with viral spillover across a diversity of contexts in Nepal. CMC is a hospital based in rural southern Nepal within the catchment area of Silinge where PREDICT is sampling rodents living in and around human dwellings and fruit bats the local population consumes for food. The second partner clinic, PAHS, located in urban Kathmandu, within the region where PREDICT is targeting macaques and rodents in urban areas, and in and around human dwellings.

### Non-human primate surveillance in the urban setting

In order to determine the potential contribution of animal-human and animal-animal interactions to disease spillover, PREDICT conducted a longitudinal study of densely populated, habituated macaques living around the Swayambhunath and Pashupatinath temples in Kathmandu. The temples have great religious significance and are popular tourist destinations in the center of the city. PREDICT conducted a population census, behavioral observation study and collected biological samples, including non-invasive urine, feces and saliva for viral testing. Together, these studies will assess the population distribution, and risk for zoonotic disease transmission to people interacting with the primates.

## Laboratory systems

PREDICT/Nepal's implementing partner the Center for Molecular Dynamics (CMDN) serves as the project lab and is actively testing animal and human samples for five viral families (corona-, filo-, flavi-, influenza-, and paramyxoviruses). The CMDN lab also supports capacity development for staff from the Central Veterinary Laboratory.

### Implementing partners

UC Davis, Center for Molecular Dynamics (CMDN).

### Contacts

**Country Coordinator:** Dibesh Karmacharya, Center for Molecular Dynamics Nepal (dibesh@cmdn.org)

**Global Point of Contact**: Dr. Christine K Johnson, UC Davis (ckjohnson@ucdavis.edu)

# THAILAND

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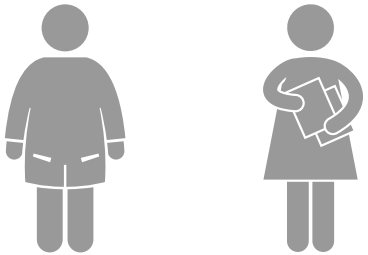
Global Health Security Agenda

## WORKFORCE DEVELOPMENT

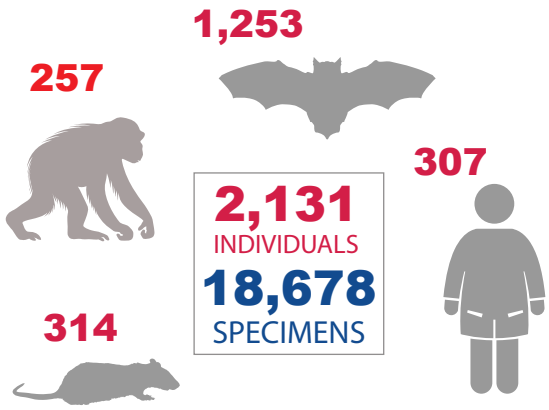
**57** STAFF

**24** GOVERNMENT



32 MALE | 8 UNKNOWN | 19 FEMALE

## ONE HEALTH SURVEILLANCE




## LAB STRENGTHENING

**12,349** TESTS

WHO-CC VIRAL ZOONOSES CHULALONGKORN UNIVERSITY

TRAINING → LIMITED TESTING → TESTING ALL TARGET VIRAL FAMILIES

## IMPACT

**59 trained** in One Health skills

**2,131 individuals sampled** (humans and animals)

**12,349 tests** for 14 viral families

**135 viruses** detected

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## VIRAL FINDINGS

| PREDICT-1 | PREDICT-2 |
|---|---|
| **83** NEW VIRUSES | **2** NEW VIRUSES |
| | **9** PREDICT-1 VIRUSES |
| **34** KNOWN VIRUSES | **7** KNOWN VIRUSES |

# PREDICT/Thailand

## Success stories

### Strengthening national influenza surveillance and reporting

PREDICT/Thailand collaborated with the Department of Disease Control, Ministry of Public Health to strengthen influenza surveillance and reporting. These efforts are specifically directed towards improving the national influenza reporting system by strengthening the capacity of diagnostic laboratories at the regional level. In March, PREDICT organized a hands-on training workshop, sponsored by the National Science and Technology Development Agency of Thailand, in which participants from 14 laboratories in the Department of Disease Control, Thai Ministry of Public Health were taught real-time PCR diagnostics for detection of influenza virus in human specimens. Following on from the training, PREDICT participated in a meeting organized by the Department of Disease Control and provided expert advice on database development for influenza surveillance in Thailand.

### One Health partnerships

PREDICT continued extensive coordination and engagement efforts between partners in Thailand aimed towards putting One Health in action. This year, the team furthered collaborations with host country organizations through planning and field-based surveillance activities. Partners include: FAO; National Science and Technology Development Agency (NSTDA); DTRA-CBEP; multiple local partners; the Office of Disease Prevention and Control 5, Ratchaburi; Health Promoting Hospital, Tambon Wat Luang; Loei hospital;

*A member of the PREDICT team conducts an interview as part of ongoing behavior risk investigations at Wat Luang village, Chonburi. May 6, 2017. Photo credit: EcoHealth Alliance*

Office of Khao Chong Pran non-hunting Area, Phu Luang; Phu Luang Wildlife Research Station; Department of National Parks; Wildlife and Plant Conservation; and Kasetsart University.

### One Health in action: Concurrent animal and human surveillance

PREDICT/Thailand conducted One Health surveillance activities by safely collecting samples from animal and human populations at three high-risk sites for zoonotic disease transmission and spread.

Together with FAO, the Department of Livestock Development (DLD), and CBEP-DTRA, PREDICT conducted triangulated human, wildlife, and domestic animal surveillance in Chonburi

province in November 2016 and February and May 2017, collecting samples from pigs and at a fruit bat colony where individuals were previously found to be Nipah virus-positive. During the May 2017 event, the team also collected samples and conducted behavioral risk interviews with 115 healthy people with high levels of human-animal contact living, working, or visiting these communities. These events also afforded PREDICT the opportunity to train DLD staff on data entry and management, improving data sharing and compatibility across the animal and human health sectors.

In Ratchaburi, bat guano miners, a high-risk occupation for disease transmission, were targeted for behavioral risk interviews and biological sample collection. Bat, rodent, and macaque specimens were also collected from the same area as part of efforts to investigate viral sharing between these closely linked populations. Previous investigations by the PREDICT team have found evidence of MERS-like coronaviruses in bat guano from this site, evidence that it is an important interface for zoonotic disease surveillance.

In Loei province, the team continued routine collection of specimens from syndromic patients at partner hospital, along with biannual collection of specimens from bats and rodents in communities within the hospital catchment area.

## Strengthening laboratory capacity for zoonotic disease detection

PREDICT enterovirus PCR protocols have been implemented at the Thai Red Cross Emerging Infectious Diseases Health Science Centre (PREDICT lab) for testing patient specimens from the Ministry of Public Health (MOPH) under the National surveillance program for hand, foot, and mouth disease. At least twenty enterovirus strains have been found from one year of surveillance. When compared to the previous year, a higher number of virus strains were found when using the PREDICT protocol.

*A macaque forages discarded fruit in an urban area with her baby at a site where PREDICT/Thailand is conducting One Health surveillance. Photo credit: Jonathan Goley/EcoHealth Alliance.*

In June 2017, PREDICT/Thailand participated in “Joint External Evaluation of IHR Core Capacity in Thailand” meeting held at MOPH, Nonthaburi. PREDICT protocols for broad viral screening at a family level were suggested as a method to detect zoonotic viruses to the committee, and examples were given to show how these new tools have been implemented in Thailand at Chulalongkorn and DLD laboratories.

## Publications

In August 2017, PREDICT/Thailand and the Ministry of Public Health (MOPH) reported detecting the first MERS case in Thailand in the journal *Eurosurveillance*. This achievement highlights how the use of multiple coronavirus and MERS-specific assays at once allows rapid detection and coronavirus sequence confirmation within 24 hours.

## Laboratory systems

PREDICT/Thailand partners with the WHO Collaborating Centre for Research and Training on Viral Zoonoses, Chulalongkorn University Hospital, Bangkok, which is actively testing wildlife and human samples for 14 viral families. PREDICT also collaborates with the National Institute of Animal Health laboratory (NIAH), which is being supported by FAO to perform for testing of pig samples for the five priority viral families. PREDICT viral testing protocols have been shared with NIAH, as well as with the Monitoring and Surveillance Center for Zoonotic Diseases in Wildlife and Exotic Animals (MOZWE), Mahidol University.

## Implementing partners

EcoHealth Alliance (EHA), Chulalongkorn University Hospital

## Contacts

**Country Coordinator:** Supaporn Wacharapluesadee, WHO Collaborating Centre for Research and Training on Viral Zoonoses, Chulalongkorn University, Bangkok (spwa@hotmail.com)

**Global Point of Contact**: Kevin Olival, EHA (olival@ecohealthalliance.org)

# VIET NAM

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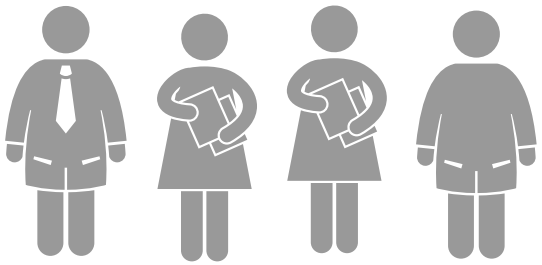
Global Health Security Agenda

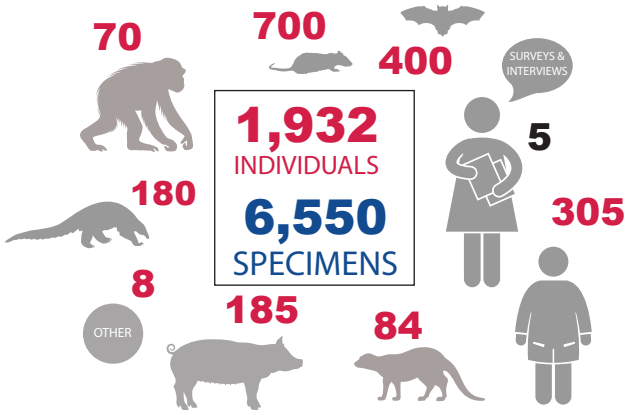
## WORKFORCE DEVELOPMENT

| 6 | 5 | 32 | 82 |
|---|---|---|---|
| STAFF | STUDENTS | GOVERNMENT | OTHER |



90 MALE | 34 FEMALE

## ONE HEALTH SURVEILLANCE




*Samples collected in collaboration with FAO

## LAB STRENGTHENING

| 1,399 TESTS | 1,610 TESTS | 518 TESTS |
|---|---|---|
| VIET NAM NATIONAL UNIVERSITY OF AGRICULTURE | REGIONAL ANIMAL HEALTH OFFICE NO. 6 | NAITONAL INSTITUTE OF HYGIENE AND EPIDEMIOLOGY (NIHE) |
| TRAINING | LIMITED TESTING | TESTING ALL TARGET VIRAL FAMILIES |

## IMPACT

**125 trained** in One Health skills

**1,932 individuals sampled** (humans and animals)

**5 individuals interviewed** in behavioral risk investigations

**3,527 tests** for 6 viral families

**32 viruses** detected

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## VIRAL FINDINGS

| PREDICT-1 | PREDICT-2 |
|---|---|
| 23 NEW VIRUSES | 2 KNOWN VIRUSES |
| 7 KNOWN VIRUSES | |

# PREDICT/Viet Nam

## Success stories

### Leveraging One Health partnerships for zoonotic disease surveillance

Following extensive stakeholder engagement, training, and preparation of supply and cold chains, PREDICT implemented concurrent human and animal zoonotic disease surveillance and behavioral risk investigations at high-risk interfaces where humans and animals interact intimately, with a particular focus on the wildlife trade and animal value chain. This year, over 1,000 samples were collected from target wildlife species (bats and rodents), and more than 1,300 specimens were collected from people. Through community engagement, several high-risk practices were identified as potential routes for zoonotic disease transmission and thus targeted for concurrent human and animal One Health surveillance. To better understand behavioral practices that could lead to disease transmission the team paired behavioral risk investigations with concurrent sampling events, targeting people engaged in the bat guano harvest in Lang Son Province, people involved in the live rat trade in Thach That District, people working on wildlife farms in Dong Nai Province and individuals from the wildlife restaurant trade.

In addition to targeting at-risk community groups, PREDICT initiated syndromic human surveillance in September, 2017, led by the National Institute of Hygiene and Epidemiology (NIHE) and in collaboration with the Thach That District hospital. This work was approved by the ethics committee at the Ha Noi School of Public Health (HSPH) in Viet Nam. HSPH is a member of the Vietnam One Health University

*A member of PREDICT's human surveillance team collects a specimen from an individual enrolled at a hospital in Viet Nam. Photo credit: WCS/Viet Nam.*

Network (VOHUN), which was established with the support of USAID and the RESPOND project to promote and develop a backbone of the One Health concept in Viet Nam. HSPH has continued to lead VOHUN under the USAID/One Health Workforce project and is collaborating with PREDICT to conduct human behavioral risk investigations.

### Workforce strengthening to improve zoonotic disease surveillance of critical species in the animal value chain

The wildlife trade interface is the focus area for PREDICT/Viet Nam. PREDICT surveillance of the wildlife trade and animal

value chain in Viet Nam focuses on collecting specimens from wildlife confiscated from the illegal trade to understand the potential for zoonotic disease transmission at this important human-wildlife interface. After building relationships with local wildlife rescue centers, PREDICT conducted a Wildlife Necropsy Workshop on September 18-22, 2017. The goal of the workshop was to increase knowledge, awareness, and expertise in wildlife necropsy techniques and protocols for veterinarians, veterinary technicians and biologists for safe sample collection from wildlife. The participants came from different organizations, including rescue centers and the non-government organizations. During the workshop, biological samples were collected from four pangolins and one civet.

## Laboratory systems

PREDICT is partnering with multiple laboratories to strengthen Viet Nam's national animal and human laboratory systems. Three animal laboratories are currently engaged: the Viet Nam National University of Agriculture (VNUA) in Hanoi, and two Department of Animal Health (DAH) Regional Animal Health Office Laboratories in southern Viet Nam: RAHO6 in Ho Chi Minh City and RAHO7 in Can Tho City. VNUA and RAHO6 are actively testing samples for priority zoonotic diseases and other emerging threats from five viral families. PREDICT has also engaged two human health-focused laboratories: the National Institute of Hygiene and Epidemiology (NIHE) in Hanoi and the Pasteur Institute (PI-HCM) in Ho Chi Minh City. NIHE is actively testing samples for five priority viral families. PI-HCM is preparing for viral testing.

## Implementing partners

Wildlife Conservation Society (WCS), Viet Nam National University of Agriculture (VNUA), the Regional Animal Health Office Laboratories RAHO6 and RAHO7, and the National Institute of Hygiene and Epidemiology (NIHE).

## Contacts

**Country Coordinators:** Nguyen Thi Thanh Nga (nnga@wcs.org) and Nguyen Van Long, WCS (nvlong@wcs.org)

**Global Point of Contact**: Amanda Fine, WCS (afine@wcs.org)

FACES OF
PREDICT

# NGUYEN THI THANH NGA

Nguyen Thi Thanh Nga is a veterinarian who graduated from Viet Nam National University of Agriculture in June 2011. Her passion for wildlife began after a volunteer research study on chytrid disease with the Wildlife Conservation Society (WCS). She joined PREDICT as a project intern and became a WCS Viet Nam Veterinary Program Officer a year later. For the last six years, Nga has strengthened her One Health skillset while working with PREDICT to prevent, detect, and rapidly respond to the spillover of potentially infectious pathogens from wildlife to humans and domestic animals. Her team has worked with partners and colleagues to build and develop the capacity for conducting One Health surveillance activities in the field and viral detection in laboratories.

"*If you cannot do great things, do small things in a great way*." –Napoleon Hill
"This quote is one of the most powerful ones that I keep reminding myself over and over again. It helps me always try my best on doing all the tasks in my job."
–Nguyen Thi Thanh Nga

2011

- Volunteered in a research study on chytrid disease with the WCS
- Graduated from Viet Nam National University of Agriculture
- Joined PREDICT Vietnam
- Became a WCS Viet Nam Veterinary Program Officer

2017

# V. PUBLICATIONS & PRODUCTS

# Publications and Products

From October 2016 to September 2017, PREDICT research led to 30 publications, including 12 original research articles. Articles appeared in many top-tier journals including *Nature, Nature Communications,* and *Emerging Infectious Diseases.* Summaries of publications are provided below, highlighting practical implications for the scientific, policy, and development sectors.

For a comprehensive bibliography containing all PREDICT publications to date, please visit:
www.publications.predict.global

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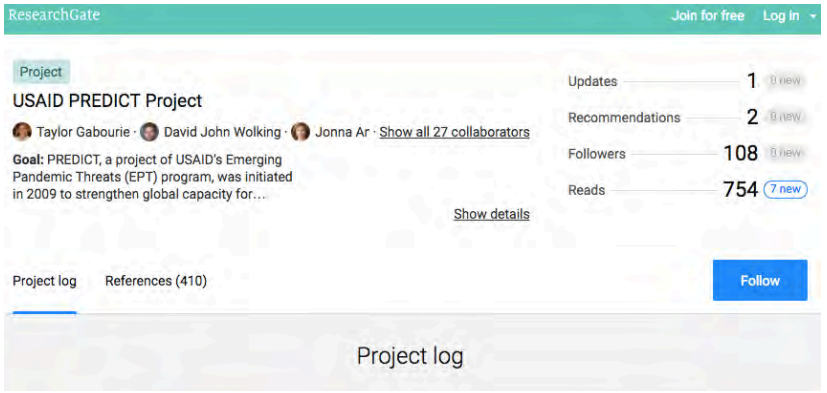
## ORIGINAL RESEARCH HIGHLIGHTS

**Cross-Sectional Surveillance of Middle East Respiratory Syndrome Coronavirus (MERS-Cov) in Dromedary Camels and Other Mammals in Egypt, August 2015 to January 2016**

**In brief:** The primary source of Middle East respiratory syndrome coronavirus (MERS-CoV) causing disease in humans is thought to be dromedary camels. Moreover, MERS-CoV is closely related to bat coronaviruses, suggesting bats might be MERS-CoV reservoirs. Most dromedary camels traded in the Middle East are bred in East African countries. Egypt imported over 1.2 million camels from 2010 to 2015.

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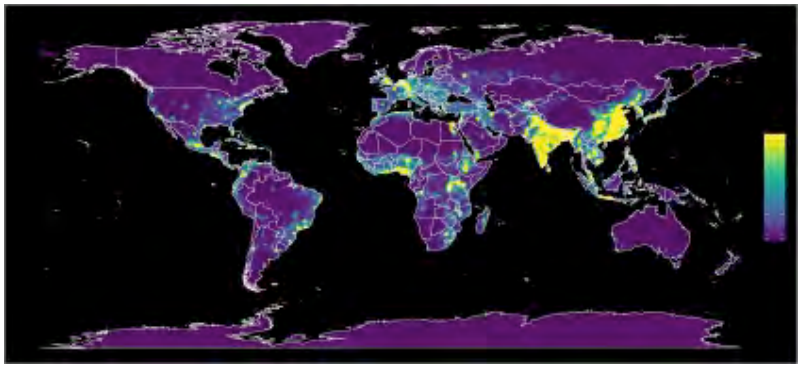
This study determined the seroprevalence of MERS-CoV in imported and resident camels, bats, domestic ruminants and equines in Egypt between August 2015 and January 2016. Overall, 84.5% (871/1,031) camels had MERS-CoV neutralising antibodies. Higher seroprevalence was found in imported (88.7%; particularly from Sudan) vs resident camels (5.8%). All domestic animals and bats were negative for MERS-CoV antibodies except one sheep apparently in contact with seropositive camels. This study shows that MERS-CoV is widespread and ubiquitous in Egypt, yet further understanding of the epidemiology of the disease along the camel market chain is needed. Moreover, findings from this study warrant the initiation of active surveillance in humans, particularly those at higher risks of exposure to MERS-CoV infections, such as camel traders and abattoir workers.

**Citation:** Ali M., El-Shesheny R., Kandeil A., Shehata M., Elsokary B., Gomaa M., Hassan N., El Sayed A., El-Taweel A., Sobhy H., Fasina F.O., Dauphin G., El Masry I., Wolde A.W., Daszak P., Miller M., VonDobschuetz S., Gardner E., Morzaria

S., Lubroth J. & Makonnen Y.J. 2017. Cross-sectional surveillance of Middle East respiratory syndrome coronavirus (MERS-CoV) in dromedary camels and other mammals in Egypt, August 2015 to January 2016. Euro Surveill. 2017;22(11):pii=30487. DOI: http://dx.doi.org/10.2807/1560-7917.ES.2017.22.11.30487

**Global Hotspots and Correlates of Emerging Zoonotic Diseases**



*Heat map of predicted relative risk distribution of zoonotic EID events.*

**In brief:** Zoonoses originating from wildlife represent a significant threat to global health, security, and economic growth, and combatting their emergence is a public health priority. However, mechanisms underlying their emergence remain poorly characterized. This study used an updated global database of emerging infectious disease (EID) events to better account for reporting effort bias and to analyze the demographic, environmental, and biological correlates of EID occurrence. The study showed that zoonotic EID risk is elevated in forested tropical regions experiencing land-use changes and where wildlife biodiversity, particularly mammal species richness, is high. A new global hotspot map of spatial variation in zoonotic EID risk index was developed, and the relationships between events and predictors were shown. This work provides knowledge to improve surveillance and long-term EID monitoring programs, as well as to better design comprehensive field experiments to test for drivers of EID risk and validate modeling outcomes.

**Citation:** Allen T., Murray K.A., Zambrana-Torrelio C., Morse S.S., Rondinini C., Di Marco M., Breit N., Olival K.J. & Daszak P. 2017. Global hotspots and correlates of emerging zoonotic diseases. Nature Communications 8: 1124 DOI: 10.1038/s41467-017-00923-8 www.nature.com/naturecommunications

**Global Patterns in Coronavirus Diversity**

**In brief:** The emergence of Severe Acute Respiratory Syndrome Coronavirus (SARS-CoV) and Middle East Respiratory Syndrome Coronavirus (MERS-CoV) have shown that bats are important reservoirs of CoVs. Despite this, only 6% of all known CoV sequences are from bats, while most are known pathogens of public health or agricultural significance. This study addressed this knowledge bias by describing 'pre-emergent' CoV diversity in bats, particularly in resource poor countries where higher risk of zoonotic emergence is predicted. The team surveyed the diversity of CoVs in multiple host taxa from twenty countries to explore the factors driving viral diversity at a global scale. Sequences representing 100 discrete phylogenetic clusters, ninety-one of them in bats, were identified. Through ecological and epidemiologic analyses it was shown that patterns of CoV diversity correlate with bat diversity, confirming that bats are the major evolutionary reservoirs and ecological drivers of CoV diversity. The study also showed that that host switching has contributed to CoV evolution and that there is regional variation in this process. This study represents a model for exploring global

viral diversity, fundamentally advancing knowledge of CoV biodiversity and the potential risk factors associated with zoonotic emergence.

**Citation**: Anthony S.J., Johnson C.K., Greig D.J., Kramer S., Che X., Wells H., Hicks A.L., Joly D.O., Wolfe N.D., Daszak P., Karesh W.B., Lipkin W.I., Morse S.S., PREDICT Consortium, Mazet J.A.K. & Goldstein T. 2017. Global patterns in coronavirus diversity. *Virus Evol* 3 (1): vex012. doi: 10.1093/ve/vex012.

**Further Evidence for Bats as the Evolutionary Source of Middle East Respiratory Syndrome Coronavirus**

**In brief:** While the evolutionary origins of Middle East respiratory syndrome (MERS) coronavirus (MERS-CoV) are unknown, current evidence suggests that insectivorous bats may be the original source. This study investigated the zoonotic risk of a MERS-like coronavirus (PREDICT/PDF-2180) identified in a bat from Uganda. The team showed that, despite being closely related to MERS-CoV, the new virus is unlikely to pose a threat to humans. Moreover, by showing that PREDICT/PDF-2180 did not infect cells that expressed the functional receptor for MERS-CoV, they determined that the critical step that allowed MERS to emerge in humans was probably recombination. Establishing the zoonotic potential of wildlife viruses is a key component of global surveillance efforts for undiscovered viruses and pandemic prevention initiatives.

**Citation:** Anthony S.J., Gilardi K., Menachery V.D., Goldstein T., Ssebide B., Mbabazi, R., Navarrete- Macias I., Liang E., Wells H., Hicks A., Petrosov A., Byarugaba D.K., Debbink K., Dinnon K.H., Scobey T., Randell S.H., Yount B.L., Cranfield M., Johnson C.K., Baric R.S., Lipkin W.I. & Mazet J.A.K. 2017. Further evidence for bats as the evolutionary source of Middle East respiratory syndrome coronavirus. mBio 8:e00373-17. https://doi.org/10.1128/mBio.00373-17.

**Occupational Risks and Exposures among Wildlife Health Professionals**

**In brief:** Many emerging zoonosis have wildlife origins, potentially placing individuals who work closely with wildlife at risk. This study used an online, confidential survey to assess occupational exposures among 71 wildlife health professionals working in 14 countries worldwide. Participants reported being exposed by bites from bats and rodents and touching dead animals. 75% had completed training in occupational safety and 80% had been vaccinated for rabies. Use of personal protective equipment included gloves for most tasks, while N95 respirators and other PPE use was more variable. This study suggests that enhanced occupational health services targeting wildlife workers could reduce the risk and sequelae of zoonotic exposure and infection.

**Citation:** Garland-Lewis G., Whittier C., Murray S., Trufan S. & Rabinowitz P. M. 2017. Occupational risks and exposures among wildlife health professionals. *EcoHealth, 14*(1), 20-28. doi:http://dx.doi.org/10.1007/s10393-017-1208-2

**Diversity of Bat Astroviruses in Lao PDR and Cambodia**

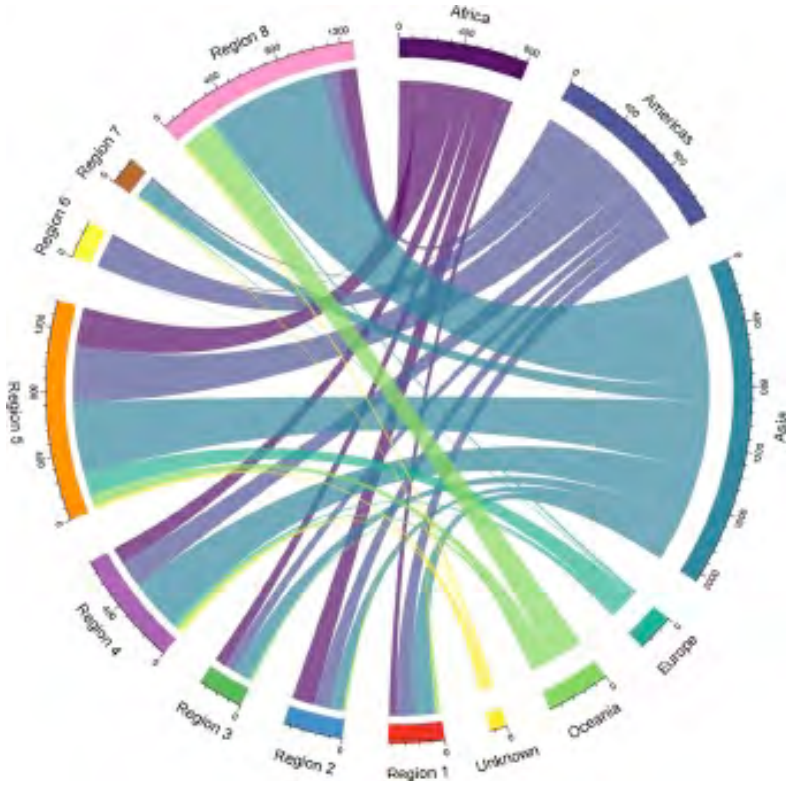
**In brief:** Astroviruses infect humans and a wide range of animal species and can cause gastroenteritis in their hosts. Recent studies have reported astroviruses in bats in Europe and in several locations in China. The team sampled 1876 bats from 17 genera at 45 sites from 14 and 13 provinces in Cambodia and Lao PDR, respectively. A high diversity of astroviruses was found among various Yangochiroptera and Yinpterochiroptera bats. The astroviruses clustered within the genus *Mamastrovirus*, most closely related to other known bat

astroviruses. Yet an astrovirus clustering in a group with other viruses from diverse hosts, including from ungulates and porcupines, was found in a *Rousettus* bat. Most of the positive bats were sampled either in guano farms or markets. This suggests that the risk of transmission to humans may exist (particularly via fecal route), especially through guano farming or when bats hunted and sold for food.

**Citation:** Lacroix A., Duong V., Hul V., San S., Davun H., Omaliss K., Chea S., Hassanin A., Theppangna W., Silithammavong S., Khammavong K., Singhalath S., Afelt A., Greatorex Z., Fine A.E., Goldstein T., Olson S., Joly D.O., Keatts L., Dussart P., Frutos R. & Buchy P. 2017. Diversity of bat astroviruses in Lao PDR and Cambodia. *Infection, Genetics and Evolution*, 47, 41-50. http://dx.doi.org/10.1016/j.meegid.2016.11.013

**Summarizing US Wildlife Trade with an Eye Toward Assessing the Risk of Infectious Disease Introduction.**

**In brief:** Anthropogenic movement of domestic and wild animals, including globalized trade, is considered a major driver for disease emergence and spread. Yet wildlife trade lacks systematic surveillance and record-keeping, representing a major gap to identify high-risk pathways for potential introduction of pathogens. This study characterized the role of the USA in the global exchange of wildlife by summarizing nearly 14 years (2000–2013) of data, involving 11 billion individual specimens and 977 million kilograms of wildlife. The majority of shipments contained mammals (27%), while the most common specimens imported were shells (57%) and tropical fish (25%). One-third of all shipments contained live animals, 77.7% wild-caught and 17.7% captive-reared. Many countries of origin for legal and illegal wildlife imports to the USA include ‘‘hotspots’’ of emerging and reemerging infectious and zoonotic pathogens.




*Circle plot representing the number of shipments (91,000) of wildlife from different continents to US regional ports of entry between 2000 and 2013.*

The study showed that the USA is a global leader in legal and illegal wildlife consumption and that the number of annual shipments doubled during the period examined. Currently, most regulatory oversight of wildlife trade is aimed at conservation, rather than prevention of disease introduction. Findings from this work reinforce the need to scale up capacity for border inspections, risk management protocols and disease surveillance.

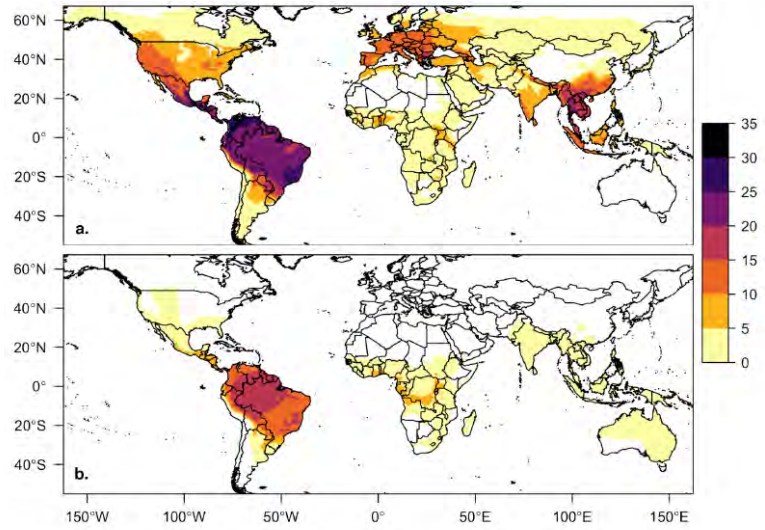
**Citation:** Smith K.M., Zambrana-Torrelio C., White A., Asmussen M., Machalaba C., Kennedy S., Lopez K., Wolf T.M., Daszak P., Travis D.A. & Karesh W.B. 2017. Summarizing US wildlife trade with an eye toward assessing the risk of infectious disease introduction. *EcoHealth*, 14(1), 29-39. doi:10.1007/s10393-017-1211-7

**Potential Sympatric Vectors and Mammalian Hosts of Venezuelan Equine Encephalitis Virus in Southern Mexico**

**In brief:** Arboviruses are important zoonotic agents with complex transmission cycles that involve many mosquito vectors and vertebrate hosts. This study searched for Venezuelan equine encephalitis virus (VEEV), eastern equine encephalitis virus (EEEV), western equine encephalitis virus (WEEV), and West Nile virus (WNV) in sympatric wild rodents (14) and bats (146) in two areas of southern Mexico. The team found six bat and two rodent species positive for VEEV. Mosquitoes known to be VEEV vectors were also found at the sites, though none were tested for arboviruses. Further investigations in sympatric nonhuman hosts, vectors, and arboviruses are needed to determine arboviral dynamics in human-disturbed environments.

**Citation:** Sotomayor-Bonilla J., Abella-Medrano C.A., Chaves A., Álvarez-Mendizábal P., Rico-Chávez O., Ibáñez-Bernal S., Rostal M.K., Ojeda-Flores R., Barbachano-Guerrero A., Gutierrez-Espeleta G., Aguirre A.A., Daszak P. & Suzán G. (2017). Potential Sympatric Vectors and Mammalian Hosts of Venezuelan Equine Encephalitis Virus in Southern Mexico. *Journal of Wildlife Diseases*. Jul 2017, Vol. 53, No. 3 (July 2017) pp. 657-661 doi:10.7589/2016-11-249

**A Comparative Analysis of Viral Richness and Viral Sharing in Cave-Roosting Bats**



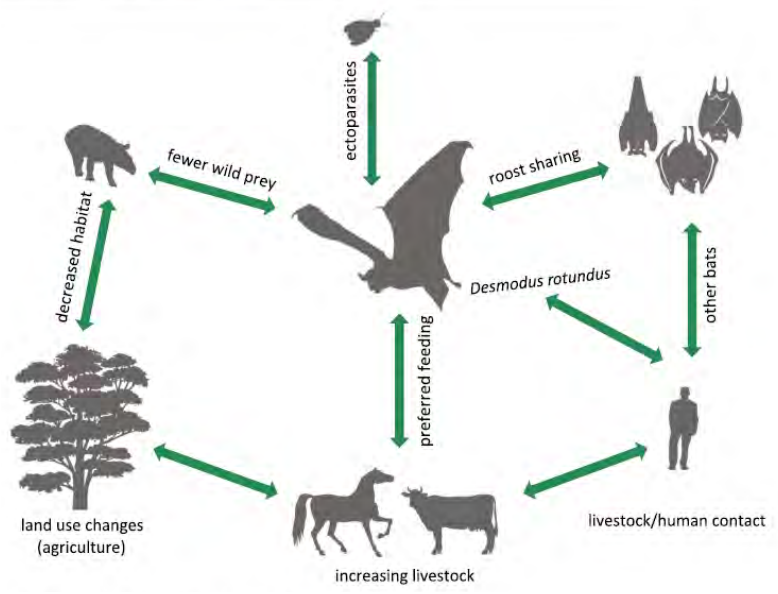

*Maps showing distribution of bat species for (a) cave-roosting bats (n = 142) and (b) non-cave-roosting bats (n = 59). Bat species richness is highest in South and Central America.*

**In brief:** Caves provide critical roosting habitats for bats globally, but are increasingly disturbed or destroyed by human activities such as tourism and extractive industries. These activities also promote contact between humans and bats, which may lead to pathogen spillover. Cave-roosting bats are hosts to emerging zoonotic viruses, such as severe acute respiratory syndrome coronavirus and Marburg virus. This study investigated the importance of roosting behavior as a determinant of viral richness and viral sharing among bat species. The team showed that cave-roosting species do not host greater viral richness, yet they exhibit a greater likelihood of viral sharing, especially in species co-roosting in the same cave. Findings from this study suggest that caves are ideal

sites for longitudinal surveillance of bat-virus dynamics. Non-invasive and non-lethal sampling methods and minimizing habitat disturbance are encouraged to ensure bat conservation.

**Citation:** Willoughby A.R., Phelps K.L., PREDICT Consortium & Olival K.J. 2017. A Comparative Analysis of Viral Richness and Viral Sharing in Cave-Roosting Bats. *Diversity*, 9, 35; doi:10.3390/d9030035

**Viral Diversity, Prey Preference, and *Bartonella* Prevalence in *Desmodus rotundus* in Guatemala**




*Desmodus rotundus ecology and interspecies interactions*

**In brief:** Some bat species serve as natural reservoirs for pathogens that may pose serious threats to human health. Due to its abundance, blood-feeding habit involving humans and domestic animals and highly social behavior, the common vampire bat (*Desmodus rotundus)* may have an unusually high potential for interspecies disease transmission. The team screened 396 blood, urine, saliva, and fecal samples from *D. rotundus* in Guatemala for 13 viral families and genera. Positive results were found for rhabdovirus, adenovirus, herpesvirus, and *Bartonella spp*. Cytochrome B sequences from fecal samples found that domestic cattle made up the majority of blood meals. Findings in this study suggest that pathogen transmission by vampire bats, including between domestic animal species, is possible and warrants further investigation. This study benefited from technological inputs and developments from PREDICT, demonstrating the growing sphere of influence of the project outside of PREDICT-participating countries.

**Citation:** Wray A.K., Olival K.J., Morán D., Lopez M.R., Alvarez D., Navarrete-Macias I., Liang E., Simmons N.B., Lipkin W.I., Daszak P. & Anthony S.J. 2016. Viral Diversity, Prey Preference, and *Bartonella* Prevalence in *Desmodus rotundus* in Guatemala. *EcoHealth*, *13*(4), 761–774. doi:10.1007/s10393-016-1183-z

**Genetically Diverse Filoviruses in *Rousettus* and *Eonycteris spp*. Bats, China, 2009 and 2015.**

**In brief:** Bats have been implicated as natural reservoirs for filoviruses. Filovirus-associated diseases, especially those caused by *Zaire ebolavirus* and Marburg virus, are recognized as a major threat to public health, causing high mortality rates among humans and nonhuman primates. This study identified genetically divergent filoviruses in *Rousettus* and *Eonycteris spp*. bats in China. Viruses found exhibited 61%–99% identity with reported filoviruses and demonstrated lung tropism. Moreover, co-infection with four different filoviruses was found in one bat. Results from this investigation show that fruit bats are important filovirus reservoirs, which may have implications

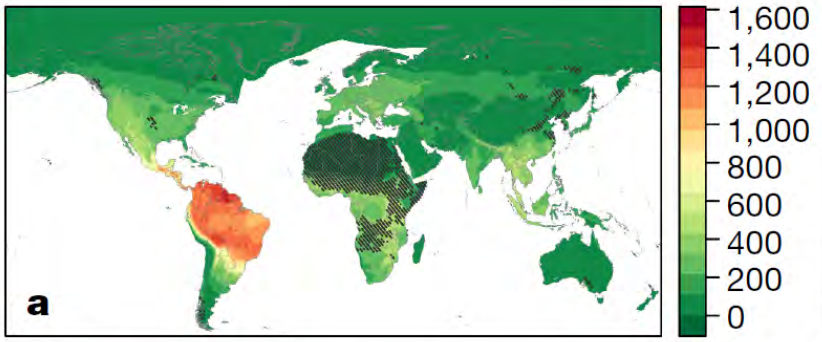
for public health. Long-term and proactive surveillance of these viruses and related diseases are recommended.

**Citation:** Yang, X. L., Zhang, Y. Z., Jiang, R. D., Guo, H., Zhang, W., Li, B., N. Wang, L. Wang, C. Waruhiu, J. H. Zhou, S. Li, P. Daszak, L. Wang & Z. Shi (2017). Genetically Diverse Filoviruses in Rousettus and Eonycteris spp. Bats, China, 2009 and 2015. *Emerging Infectious Diseases*, 23(3), 482-486. http://dx.doi.org/10.3201/eid2303.161119

**Host and viral traits predict zoonotic spillover from mammals**

**In brief:** The majority of human emerging infectious diseases are zoonotic, with viruses that originate in wild mammals of particular concern. However, few analytical tools exist to identify where to search for these viruses. Through a comprehensive analysis of mammalian host–virus relationships, this study showed that both the total number of viruses that infect a given species and the proportion likely to be zoonotic are predictable. Specifically, the proportion of zoonotic viruses per species was found to be predicted by phylogenetic relatedness to humans, host taxonomy, and human population within a species range—which may reflect human–wildlife contact. In this sense, the team determined that bats harbor the highest proportion of zoonotic viruses. As per the potential of viruses to be zoonotic, this study found that phylogenetic host breadth and other viral traits were useful predictors. The team used these tools to identify taxa and geographic regions with the highest value for future surveillance.

**Citation:** Olival K.J., Hosseini P.R., Zambrana-Torrelio C., Ross N., Bogich T.L. & Daszak P. 2017. Host and viral traits predict zoonotic spillover from mammals. 646, *Nature*, Vol 546. http://www.nature.com/doifinder/10.1038/nature22975




*Areas predicted to be of greatest value for discovering novel zoonotic viruses considering all wild mammals*

## PERSPECTIVES

**One Health, emerging infectious disease and wildlife: two decades of progress?**

**In brief:** Infectious diseases affect people, domestic animals, and wildlife alike, with many pathogens capable of infecting multiple species. A synthesis published by the authors in 2000 identified common anthropogenic drivers of disease threats to biodiversity and human health, including encroachment and destruction of wildlife habitat and the human-assisted spread of pathogens. In this follow up assessment, almost two decades later, they show the situation has not changed and, despite improved knowledge of the underlying causes, little has been done at the policy level to address these threats. This publication highlights the need to work better to conserve nature and preserve the ecosystem services that biodiversity provides, including disease regulation, while also understanding and mitigating human activities which lead to disease emergence. To increase chance of success, a One Health approach to the management and mitigation of the risks of emerging infectious diseases is recommended.

**Citation:** Cunningham A., Daszak P. & Wood J.L.N. (2017). One Health, emerging infectious disease and wildlife: two decades of progress? *Philosophical Transactions of the Royal Society B,* 15(40). http://dx.doi.org/10.1098/rstb.2016.0167

**Checklist for One Health Epidemiological Reporting of Evidence (COHERE)**

**In brief:** This report provides a Checklist for One Health Epidemiological Reporting of Evidence (COHERE), developed by a multidisciplinary team, to guide the design and publication format of future One Health studies. The COHERE standards aim to improve the quality of reporting of One Health studies and to encourage integration of knowledge from humans, animals and/or vectors, and their environments in all One Health studies. The COHERE checklist includes 19 standards that address descriptions of human and animal populations, environmental assessment, spatial and temporal relationships of data from the three domains, integration of analyses and interpretation, and inclusion of human, animal, and environmental health experts in research teams.

**Citation:** Davis M.F., Rankin S.C., Schurer J.M., Cole S., Conti L., Rabinowitz P. & COHERE Expert Review Group. 2017. Checklist for One Health Epidemiological Reporting of Evidence (COHERE). *One Health*, Volume 4, Pages 14-21, ISSN 2352-7714, https://doi.org/10.1016/j.onehlt.2017.07.001. (http://www.sciencedirect.com/science/article/pii/S2352771417300022)

**Does the Impact of Biodiversity Differ Between Emerging and Endemic Pathogens? The Need to Separate the Concepts of Hazard and Risk**

**In brief:** Biodiversity is of critical value to human societies, but evidence that biodiversity may mitigate infectious disease risk remains controversial. The authors suggest that this lack of acceptance likely results from deficiency of focus on disentangling interactions between human activities and pathogen circulation in wildlife. Two alternative approaches are offered in this publication First, authors suggest clarifying the concepts of hazards (potential source of harm) versus risks (the likelihood of adverse events caused by exposure to a hazard). This differentiates disease emergence drivers in humans from the general relationship between biodiversity and endemic pathogen transmission. Second, they highlight that the interactive relationship among biodiversity, anthropogenic change, and zoonotic disease risk, including both direct and indirect effects, needs to be recognized and taken into account. The authors emphasize that with this added knowledge, conservation efforts could mitigate disease risks and hazards.

**Citation:** Hosseini P.R., Mills J.N., Prieur-Richard A.H., Ezenwa V.O., Bailly X., Rizzoli A., Suzán G., Vittecoq M., García Peña G.E., Daszak P., Guégan J.F. & Roche B. 2017. Does the impact of biodiversity differ between emerging and endemic pathogens? The need to separate the concepts of hazard and risk. *Phil. Trans*. R. Soc. B 372: 20160129.http://dx.doi.org/10.1098/rstb.2016.0129

**One Health Proof of Concept: Bringing a Transdisciplinary Approach to Surveillance for Zoonotic Viruses at the Human-Wild Animal Interface**

**In brief:** The One Health approach presents opportunities to reduce the impact of disease emergence events and to mitigate future emergence through improved cross-sectoral coordination. This publication presents proof of concept of the utility of the One Health approach, as undertaken by the US Agency for International Development's PREDICT project consortium through collaborative, transdisciplinary partnerships. The study shows that PREDICT has enabled significant improvements of knowledge on the zoonotic pool of viruses and the risk of exposure to people, leading to more 90 peer-reviewed, scientific publications in under 5 years from PREDICYT-1. It also demonstrates that this knowledge is assisting in global health improvements, including surveillance science, diagnostic technologies, understanding of viral evolution, and ecological driver identification. The authors highlight that by emphasizing the links among human, animal, and environmental health, PREDICT enabled and supported integrated efforts across disciplines and geographic boundaries in over 20 countries worldwide, to promote public health, effective natural resource management, and socio-economic development.

**Citation**: Kelly T., Karesh W., Johnson C., Gilardi K., Anthony S., Goldstein T., Olson S., Machalaba C., PREDICT Consortium & Mazet J. 2017. One Health proof of concept: Bringing a transdisciplinary approach to surveillance for zoonotic viruses at the human-wild animal interface. *Journal of Preventive Veterinary Medicine:* 137(B): 112–118. http://dx.doi.org/10.1016/j.prevetmed.2016.11.023

**One Health Economics to Confront Disease Threats**

**In brief:** Global economic impacts of epidemics suggest high return on investment in prevention and One Health capacity. However, such investments remain limited, contributing to persistent endemic diseases and vulnerability to emerging ones. This publication reports outcomes from an interdisciplinary workshop that explored methods for added value of One Health approaches to disease control at the country-level. Key recommendations include: 1) systems thinking to identify risks and mitigation options for decision-making under uncertainty; 2) multisectoral economic impact assessment to identify wider relevance and possible resource-sharing, and 3) consistent integration of environmental considerations. The authors suggest that economic analysis can complement other diverse impact metrics.

**Citation:** Machalaba C., Smith K.M, Awada L., Berry K., Berthe F., Bouley T.A., Bruce M., Cortiñas Abrahantes J., El Turabi A., Feferholtz Y., Flynn L., Fournié G., Andre A., Grace D., Jonas O., Kimani T., Le Gall F., Miranda J.J., Peyre M., Pinto J., Ross N., Rüegg S.R., Salerno R.H., Seifman R., Zambrana-Torrelio C. & Karesh W.B. 2017. One Health Economics to confront disease threats. *Trans R Soc Trop Med Hyg* 2017; 111: 235–237. doi:10.1093/trstmh/trx039

**Veterinary Epidemiology: Forging a Path toward One Health**

**In brief:** This manuscript summarizes a panel discussion on One Health held during the International Society of Veterinary Epidemiology and Economics (ISVEE) conference in 2015. The team reported an increase in the use of the term over time, particularly since 2009, and in reference to work carried out in at least 41 countries. The group concluded that further development of dynamic, transdisciplinary collaborations; new

mechanisms for obtaining, integrating, and interpreting data from diverse sources; the identification of One Health joint priorities and resources for the veterinary and public health professions; and operationalization and institutionalization of One Health are needed.

**Citation:** Mardones F., Hernandez-Jover M., Berezowski J., Lindberg A., Mazet J. & Morris R. 2017. Veterinary epidemiology: Forging a path toward one health. *Preventive Veterinary Medicine*, 137(B): 147-150.

## BOOK CHAPTER

### Global Environmental Change and Emerging Infectious Diseases: Macrolevel Drivers and Policy Responses

**In brief:** The prediction of emerging infectious diseases (EIDs) and the avoidance of their vast social and economic costs requires the identification of their most likely drivers. Given that the drivers of global environmental change and biodiversity loss are often the drivers of EIDs, there are opportunities for health and biodiversity sectors to work synergistically at local and global levels. This chapter suggests policy and practice-based actions toward the prevention of EIDs in the context of environmental change and identifies knowledge gaps for the purpose of further research.

**Citation:** Machalaba C., Romanelli C. & Stoett P. 2017. Chapter 2: Global Environmental Change and Emerging Infectious Diseases: Macrolevel Drivers and Policy Responses. In *Examining the Role of Environmental Change on Emerging Infectious Diseases and Pandemics* (pp. 24–67). Hershey, PA: IGI Global. doi:10.4018/978-1-5225-0553-2

## COMMENTARY

### Prioritizing the "Dormant" Flaviviruses

**In brief:** In this opinion article, the authors use Zika as an example to highlight the need to reverse the global approach to emerging infectious disease research, which has historically been reactive, with an increase in investigations and funding only coming after international spread. The authors suggest setting research priorities for quiescent, already known viruses particularly in the genus flavivirus, now, before they become the next Zika.

**Citation:** Olival K.J. & Willoughby A.R. 2017. Prioritizing the "Dormant" Flaviviruses. *EcoHealth*, *14*(1), 1–2. doi:http://dx.doi.org/10.1007/s10393-017-1220-6

### Avoiding Catastrophes: Seeking Synergies among the Public Health, Environmental Protection, and Human Security Sectors

**In brief:** This essay reports conclusions from a workshop held at Concordia University in Montreal, Canada in 2016. Experts in medicine, human rights, ecology, biodiversity, zoonotic disease, public health, health-care systems, war, genocide, and disaster-risk reduction explored new opportunities to achieve greater understanding of the interplay between public health, conflict, and environmental degradation to avert catastrophe when these components spiral out of control. Participants committed to engage in further collaborative multidisciplinary work, focused on policies, legislative frameworks, governance structures, and strategic investments to support an agenda for sustainable development that respects ecological dynamics and thresholds, basic resource needs, cultural variability, and the fundamental right to human security in line with a vision to achieve planetary health.

**Citation:** Stoett P., Daszak P., Romanelli C., Machalaba C., Behringer R., Chalk, F., Cornish S., Dalby S., Ferreira de Souza Dias B., Iqbal Z., Koch T., Krampe F., Lo M., Martin K., Matthews K., Nickerson J.W., Orbinski J., Price-Smith A., Prieur-Richard A.H., Raja A., Secko D.M., Suazo A. & Swain, A. 2016. Avoiding catastrophes: seeking synergies among the public health, environmental protection, and human security sectors. *The Lancet Global Health*, 4(10). doi:10.1016/s2214-109x(16)30173-5

## REVIEW

### Evaluating One Health: Are We Demonstrating Effectiveness?

**In brief:** The benefits of a One Health approach are expected to be linked to increasing public health efficiency and cost effectiveness through a better understanding of disease risk and the production of results that benefit human, animal ,and ecosystem health. However, One Health metrics are rarely used to evaluate outcomes of implemented interventions. The team conducted a review of One Health literature for case studies reporting metrics. Of 1839 papers analyzed, only seven reported quantitative outcomes, while in others success was often assumed without supporting evidence or determined subjectively. Noting that lack of standardized metrics may hinder the more widespread adoption of One Health, the authors suggest outcome metrics for evaluation of One Health, highlighting relevant cost outcomes.

**Citation:** Baum S.E., Machalaba C., Daszak P., Salerno R.H. & Karesh W.B. 2017. Evaluating one health: Are we demonstrating effectiveness? *One Health*, 3, 5-10. doi:10.1016/j.onehlt.2016.10.004

### Wildlife Hosts for OIE-Listed Diseases: Considerations Regarding Global Wildlife Trade and Host-Pathogen Relationships.

**In brief:** The expanding international wildlife trade represents a potential pathway for transboundary disease movement. While this trade represents over US $300 billion per year industry involving exchange of billions of live and dead animals and animal and plant products, surveillance and reporting of OIE-Listed diseases in wildlife are often opportunistic. The team reviewed peer-reviewed literature for reports of 73 OIE-listed terrestrial animal diseases in wild animals and found 528 possible wild animal hosts. While not all host-pathogen relationships indicate that a particular species plays a significant role in the transmission of disease, the authors suggest that improved reporting of infections in wild animals would contribute to improved One Health risk assessments.

**Citation:** Smith K.M., Machalaba C.M., Jones H., Cáceres P., Popovic M., Olival K.J., Jebara K.B. & Karesh W.B. 2017. Wildlife hosts for OIE-Listed diseases: considerations regarding global wildlife trade and host-pathogen relationships. *Veterinary Medicine and Science*. doi:10.1002/vms3.57

## OTHER PUBLICATIONS BENEFITING FROM PREDICT SUPPORT

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Ji W., Zhang L., Guo Z., Xie S., Yang W., Chen J., Wang J., Cheng Z., Wang X., Zhu X., Wang J., Wang H., Huang J.,

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## SELECTED OUTREACH PRODUCTS

- Communication campaign picture book, “Living Safely with Bats”
- Blog posts on opportunities for health disaster risk reduction on the UN’s “PreventionWeb” knowledge platform (with partners from UNISDR, World Bank, and CBD).
- Post on the *Lancet Global Health* blog on disease drivers and animal vaccination targets to optimize the Coalition for Epidemic Preparedness innovation (CEPI - with partners from the World Bank, Harvard and OIE: Available online).
- ‘One Health in Action’ case study booklet (English and French).
- A briefing document on the role of environment in One Health and national health security.

For more information on PREDICT publications and products please visit: http://publications.predict.global

# In the Media

PREDICT was featured in a number of films/videos, radio programs, news articles, and press releases, further extending the project's global reach. Links to news and other media are found on the PREDICT website and Twitter.

PREDICT news:
http://www.vetmed.ucdavis.edu/ohi/predict/predict_news_and_impact.cfm

@PREDICTProject: https://twitter.com/predictproject

## Featured stories

**60 Minutes: *Veterinarians Help Save Africa's Endangered Mountain Gorilla***

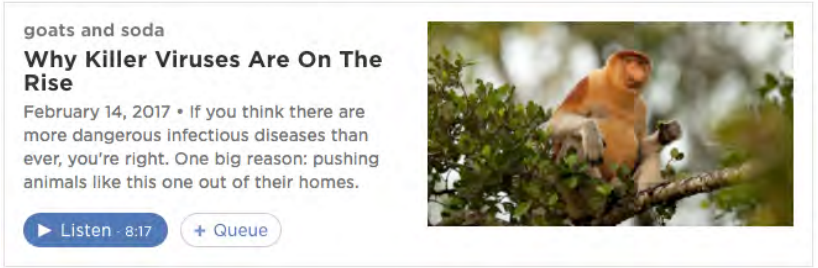
The CBS program 60 Minutes aired an episode entitled "Gorilla Doctors" featuring members of the PREDICT/Uganda, Rwanda, and DRC teams on October 9, 2016.

**National Public Radio's All Things Considered: *The Next Pandemic Could be Dripping on your Head***

On February 21, 2017, PREDICT's Kevin Olival was interviewed on NPR about PREDICT/Indonesia's work with bats in caves at the high-risk ecotourism interface.

**National Public Radio's All Things Considered: *Why Killer Viruses Are on the Rise***

On February 14, 2017, PREDICT's Kevin Olival was interviewed on NPR about his work in Borneo with the PREDICT/Indonesia team at high-risk sites where pandemics may emerge.


goats and soda
Why Killer Viruses Are On The Rise
February 14, 2017 • If you think there are more dangerous infectious diseases than ever, you're right. One big reason: pushing animals like this one out of their homes.
Listen · 8:17
+ Queue

**The Week (produced by STAT News): *There are more than 1 million viruses that we know absolutely nothing about***

Members of USAID's Emerging Pandemic Threats program, PREDICT, and the Global Virome Project were featured in this article exploring risks of responding to infectious disease threats after they have emerged and highlighting work to "let data drive a much more robust line of investment against risk, not just what it is that's kicking the door in at the moment."

**STAT News: What's the next global disease threat? Some predictions**

In this article, PREDICT's Kevin Olival discusses our work to "figure out what might cause future disease outbreaks before spread ignites, so the world can develop vaccines or drugs with which to respond."

**Scientific American: *The Next Zika***

PREDICT's Brian Bird, was featured in an article in *Scientific American* related to mutations of Rift Valley virus on October 11, 2016.

**The Virus Hunters – a case study**

On May 25, 2017, Dr. Prime Mulembakani, PREDICT/DRC Country Coordinator was featured in a Case Study on PREDICT activities in the DRC, published by UnDark, an online independent non-profit journalism studio.

CASE STUDIES / News & Features
The Virus Hunters
In the Democratic Republic of the Congo, teams of researchers are busy looking for the next deadly virus. The odds are not in their favor.
05.25.2017 / BY Jeffrey Marlow

**Time Health: Bats are the number-one carriers of disease**

In this article, PREDICT's Kevin Olival discusses our analysis of viruses known to infect mammals, to calculate the number of viruses from each species and identify characteristics that make the transmission to humans more likely.

**Nature and Science Daily: Bats are a reservoir for Coronaviruses**

In June, two news articles were published in Nature and Science Daily, respectively. Both features highlight the findings of a global analysis of bat coronaviruses discovered during PREDICT.

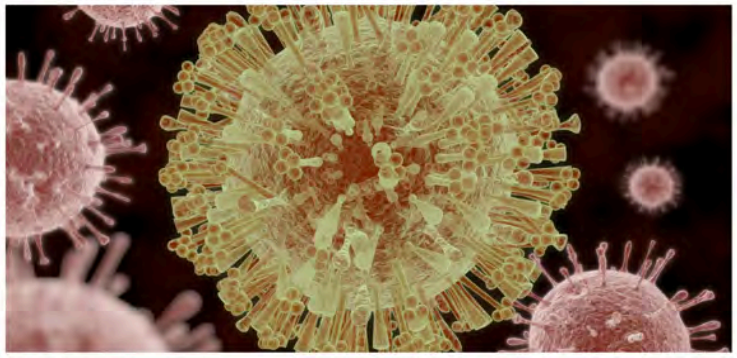
NATURE | NEWS
Bats are global reservoir for deadly coronaviruses
Finding could help researchers to better predict where these viruses are likely to make the jump from animals to people.
Amy Maxmen

**MERS-like coronavirus identified in Ugandan bat**

An article was published in Phys.org summarizing the PREDICT publication in mBio, in which PREDICT's Simon Anthony described the discovery a novel coronavirus in a bat from Uganda that is similar to the one causing Middle East Respiratory Syndrome (MERS).

**From wildlife to humans with the PREDICT project**

PREDICT's Tracey Goldstein was interviewed by the Infectious Diseases Hub, an online resource for research and informational aspects of virology and microbiology.



From wildlife to humans with the PREDICT project – an interview with Tracey Goldstein

AUTHORS: MARTHA POWELL, FUTURE SCIENCE GROUP

## Film and video

**Emerging Pathogen Surveillance**

On January 13, 2017, PREDICT's Global Director Jonna Mazet, was interviewed by Vincent Racaniello from Columbia University at the Emerging Infectious Diseases A to Z (EIDA2Z) conference hosted by the National Emerging Infectious Diseases Laboratories.

**Tusk Award for Conservation in Africa Finalist**

Olivier Nsengimana, a veterinarian trained by the PREDICT and Gorilla Doctors programs, is now on a one-man mission to save the grey crowned cranes in Rwanda.

## Radio

**MicrobeTalk Podcast**

The Microbiology Society, which is based in Europe and interviews researchers about viruses, bacteria, and parasites, spoke to PREDICT's Jonna Mazet about capacity building in areas of the world most at risk for disease emergence and spillover events.

**National Public Radio's Generation Listen**

PREDICT's David Wolking joined NPR Generation Listen journalists at the Redwood Regional Park in Oakland, California to discuss PREDICT's role in preparing for the next pandemic. Additionally PREDICT's Dr. Kevin Olival joined

*Reporter Lesley McClurg (left) and David Wolking from USAID's PREDICT kick off the afternoon at Redwood Regional Park.*

Generation Listen in New York City to talk about PREDICT's work in bat caves in Malaysia and to lead a night hike identifying some of New York's local bat species.

## News articles

**FRONTLINES – USAID**

The PREDICT/Nepal team was featured in an in-depth story on the USAID frontlines publication.

**Awards for Research Excellence and Leadership**

This year, PREDICT's Global Director Dr. Jonna Mazet was received three awards recognizing her contributions to global health research and leadership including; the UC Davis School of Veterinary Medicine Zoetis Award for Research Excellence, the 2017 University of California Remarkable Women award, and the Consortium of Universities for Global Health (CUGH) Leadership Award.

**CIFOR Day at USAID: Integrating Biodiversity and Forests into Key Development Objectives**

USAID's Office of Forestry and Biodiversity (FAB) and the Center for International Forestry Research (CIFOR) teamed up with PREDICT team members in October 2016 to discuss areas for collaboration in Central Africa, specifically focusing on bushmeat and the bushmeat value chain.

**Finding the worlds unknown viruses – before they find us**

The Global Virome Project (GVP), a novel and innovative effort influenced by work conducted by PREDICT and featuring many PREDICT team members is featured in this article, which highlights how GVP is seeking to identify the majority of the world's viruses likely to infect humans.

**Smithsonian's National Zoo & Conservation Biology Institute**

In four separate articles, PREDICT's work in Myanmar is highlighted along with many facets of the project and PREDICT/Myanmar team members. Earth Optimism, Bats in Myanmar, Predicting Future Global Health, Predicting the Future of Global Health: Kenya

## Blogs and features

**Pandemics and Deforestation: A Surprising Connection**

On March 3, 2017, PREDICT was featured in a blog post on the Partnership for Global Health Technologies website. The partnership connects students from Boston University and universities abroad who have a shared passion for improving healthcare in the developing world.

**How I got my dream job as a wildlife veterinarian**

On March 24, 2017, PREDICT/Myanmar's global lead Dr. Marc Valitutto was featured in a Fast Company article describing his career trajectory and the opportunities gained through working with PREDICT.

> "The work that I do has an impact–not just on animal species but on everyone and everything."

## Social media

### Twitter

In the past year, @PREDICTproject has posted 221 tweets related to PREDICT activities and associated articles. Expanding global reach, @PREDICTproject has 484 followers.

PREDICT @PREDICTproject · Jul 28
Our #Tanzania team donning life vests before PPE on the boat to #Gombe to collect samples from non-human primates

### YouTube

The UC Davis One Health Institute YouTube channel featured a student's perspective on the Rx One Health field training course attended and hosted by PREDICT team members.

## Press releases

**Good emergency management practices (GEMP) workshop in Tanzania.** FAO. February 24, 2017.

***Celebrity Vet Promotes USAID Counter Wildlife Trafficking Efforts.*** USAID. March 15, 2017.

**$28.8 million for PREDICT-2" from the United States Agency for International Development.** University News. October 31, 2016.

USAID
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